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QUARTERLY BUSINESS CAPITAL EXPENDITURES

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This paper reports on the research underlying the business capital expenditure equations used in RDX1, the experimental aggregate model of the economy being developed in the Research Department of the Bank of Canada. The views expressed are the personal views of the authors and no responsibility for them should be attributed to the Bank.

PREFACE

This study explains the theory and empirical experiments underlying the two business fixed capital expenditure equations used in RDX1, an aggregate quarterly model of the Canadian economy. Econometric descriptions of behaviour are never final, even when the behaviour in question is fairly straightforward. In the field of investment behaviour, where decision-makers and researchers alike operate under conditions of considerable uncertainty, almost any equation must be regarded as a stopgap whose use is only justified under the pretext that it is temporary. Even while research is continuing it often makes sense to stop and chronicle the progress to date, in part to help others on the same route and in part to clarify the remaining problems. When one must produce some equation or other in a specified time, as we had to do for the RDX1 model, there is an added incentive to spell out progress to date so that the equation can be duplicated for the aggregate model.

To Ian Stewart and the rest of the group assembling the equations for the aggregate RDX1 model, we are grateful for the questions they raised that eventually led to a number of subtle flaws being removed from our data and specifications. If an independent group had not been trying to duplicate our equations on the basis of our written reports, a number of mistakes in both would have remained undiscovered. The experience has taught us to institute such duplication wherever our equations are to be put to use, and to write up our equations in such a way that other researchers should likewise be able to obtain the same results. Thus we have written our report describing our experiments in some detail, and in a serial manner. Even if the chronicle of our search may not always make gripping reading, at least our footsteps should be clear.

We would be grateful if other investigators would let us know when they succeed where we have failed.

The Research Department of the Bank of Canada, though not responsible for any of the views in this paper, did provide excellent research facilities, a stimulating environment and lots of encouragement for a search that had many discouraging moments.

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A. Introduction

Efforts to construct models of the capital investment process in Canada on a quarterly basis are of necessity somewhat constrained in their scope. In the first place, no disaggregation is possible beyond the level of non-residential construction and machinery and equipment expenditure, since quarterly data at a finer level do not exist. Even the aggregate quarterly figures are rather suspect, being built up from price and employment data for construction and from shipments data for machinery and equipment. Thus there are no 'real' figures at all on a quarterly basis.

There are two ways of dealing with this situation. One way is to proceed as though the quarterly capital expenditures figures were actual observations and hope that the errors in the variables are not large and not systematic enough to bias the resulting estimates seriously. This approach precludes disaggregated investment equations, but ties in straightforwardly with an aggregate quarterly model.

A second way of dealing with the problem is to look further afield for alternative sources of investment data, even if that involves moving out of a strict quarterly framework. In Canada, one has to go to the results of the annual investment survey to find a direct measure of investment put in place during a particular time period. The survey provides no information about the quarterly allocation of investment outlays but does allow disaggregation to the sector, the industry, or even the enterprise level, and provides forecast as well as actual capital expenditures for each calendar year. This survey information supplies an alternative route to aggregate quarterly investment equations and the only possible source of either quarterly or annual disaggregated capital expenditures equations. The way we envisage using this information in a quarterly model is to have equations explaining the most recent annual investment forecast, equations (called realizations functions) explaining the difference between the current annual actual and forecast expenditures, and a non-stochastic

scheme for allocating the estimate of the current year's actual expenditures among the four quarters. The forecast equations and the realizations functions would be unusual in that, although the values of the independent variables would change each quarter, the dependent variables (being based on observed annual figures) would have the same values in four successive quarters. The success of this approach depends on the quality of the forecasts and realizations functions, and on the a priori plausibility of whatever scheme is used for the quarterly allocation of the estimated annual actual expenditures. There can be no straightforward contest between this approach and the first approach using the quarterly expenditures data, since there are no actual quarterly expenditures data to provide a standard of performance. The second approach is not likely to explain the existing quarterly expenditures series as well as the first approach. Nor is it intended to do so, since the second approach specifically rejects the assumption that the present quarterly series are the best approximation to investment actually put in place during the quarter. In pursuing the second approach, we have done a considerable range of experiments with realizations functions; to be reported in a separate paper. For the aggregate quarterly RDX1 model,[1] however, we are relying entirely on the first approach, both because of its simplicity and because of the apparent plausibility of our results.

The present paper deals only with our experiments using the quarterly national accounts figures for machinery and equipment (M&E) and non-residential construction (NRC) as the dependent variables. Section B presents the model and discusses the basic data. Section C presents the results of our first phase experiments explaining gross capital expenditures. The experiments presented in Section D use the results of the first phase equations to construct net investment variables which are then used in attempts to find the influence of financial factors on the size and timing of investment outlays.

There are more data problems encountered at this stage, as the price data both for capital goods and for output are not reliable enough to provide any measure of the relative cost-of-capital services figuring prominently in the Fisherian theory of

[1]An experimental prototype model of the Canadian economy which is under development in the Research Department of the Bank of Canada.

optimal investment. Some efforts were made to work with existing price data but these were not successful. The data referring to the cost of finance also gave rise to conceptual and estimation problems.

Section E presents the final phase two equations and puts them through some preliminary forecasting tests. Section F describes some further experiments designed to improve the M&E equation and runs our final equations through further forecasting tests. The preferred equations are, as usual, a compromise between the type of structure that we would like to see on a priori theoretical grounds and the equations that our existing data would support with some degree of plausibility. Our final equations are quite satisfactory on any a priori criterion, but they are not perfect and they do not embody all the effects that we would like to see. This may be due to inadequacies of data, to mistaken specification, or to both.

B. The Model

1. Preliminary Structure

The model we have used for both non-residential construction and machinery and equipment investment is a flexible accelerator pattern with the basic equation:[2]

$$I_t^g = a + b(KGAP)_t + cK_{t-1} \qquad (1)$$

Here I_t^g is gross investment quarterly, K_{t-1} is the size of capital stock at the end of quarter $t-1$; so cK_{t-1} represents replacement investment and c is an estimate of the proportion of the capital stock that is replaced in each period. $(KGAP)_t$ is the accelerator term, representing the discrepancy between desired and actual capital stock, which then gives rise to new capacity-expanding investment in period t. Since time is required both for the investment decision to be taken and for the plant and equipment to be produced and installed, we assume that present expansionary investment put in place is composed of investment

[2]The definitions of all the variables used in the paper are set out in Appendix B.

related to a number of past periods' capital shortages, so:

$$(KGAP)_t = \sum_{i=0}^{n} W_i (K^*_{t-i} - K_{t-i-1}) \qquad (2)$$

$$\sum_{i=0}^{n} W_i = 1$$

A change has to be thought to have some permanence before it is used as a basis for planning additions to productive capacity. Although current information is probably more relevant to expectations than are long past values of variables, the past values may still have some importance in helping to decide whether current values are good indicators of the future. Thus, several past values of some variables are likely to have some importance when decisions are made about what expenditures should be undertaken. The relative importance of various lagged values presumably depends on the type of variable whose future values are being forecast by the decision maker. Once decisions have been made about what capital expenditures to undertake, the actual capital expenditures will be distributed among subsequent time periods. If it is possible to separate investment decisions from investment expenditures, then these two sorts of lag may be distinguished. In Canada, we have only the aggregate quarterly expenditures data to explain, so there is no chance of sorting the pre-decision formation of expectations from the post-decision time distribution of actual expenditures. Thus, all we can get from our data is a single lag distribution, which may be considered to be a convolution of the pre- and post-decision distributions. It is important to remember this fact, lest we be tempted to regard the W_i as the lag distribution of expenditures behind appropriations[3] (expenditure decisions), and b as a measure of the elasticity of expectations.

Since there will be times when we have to make assumptions

[3]"Appropriations" refer to allocations of funds by firms for specific investment projects, and provide the best evidence about the timing of investment decisions. If appropriations data are available, it is possible to estimate separately the time shape of the variables influencing investment decisions and the lag structure linking investment decisions and actual outlays. Almon [1] and Hart and Sachs [25] have attempted to explain the latter relationship using U.S. data, while Hart [12] has also made some efforts to explain appropriations themselves. There are no Canadian appropriations data, so we could not follow this routine.

about the separate time structures of the pre- and post-decision lag structures, it is worthwhile exploring the possibilities. Under what circumstances might it be possible to regard the W_i as the lag structure relating appropriations and actual expenditures?

1. If the structure of the W_i is very close to the lag structures explicitly relating the National Industrial Conference Board U.S. quarterly appropriations to actual expenditures, then we should be more willing to interpret the W_i in the same way, having regard to the dangers involved in assuming that U.S. experience is directly applicable to investment behaviour in Canada.

2. If the definition of K^* includes all the past values, appropriately weighted, of the variables influencing current investment decisions, then the case becomes stronger for treating b as a scale factor indicating the elasticity of expectations with respect to the weighted combination of past values of the variables affecting K^*. If it were possible to so interpret b, then the W_i would be left to represent only the lag between appropriations and actual expenditures.

Our definition of K^* involves only Y_t as a proxy for future output, while it is likely that a weighted average of several recent values would provide a more appropriate measure.[4] If, for example, the appropriate way of measuring expected future output were to use all past values with geometrically declining weights, then our W_i are the weights resulting from the convolutions of two lag structures. What could we say, in this case, about the relationship between the two component distributions? Not much, beyond saying that the actual lag distribution of expenditures behind appropriations must reach a peak sooner, and be more compact, than the associated distribution of W_i.

The important conclusion from this discussion is that no empirical tests within our present framework will allow us to tell how our single lag distribution relating past experience to current expenditures can be split into pre-decision and post-decision dis-

[4]This implies regressive expectations. Extrapolative expectations are also possible, in which case the appropriate value for expected future output would be an extrapolation based on recent output values.

tributions. This fact becomes important when we are including policy variables in our investment equation. If, for example, a policy variable enters K^* in the same way as does Y_t, we are thereby assuming that lagged values of the policy variable enter into the formation of expected future values with exactly the same weighting pattern as past values of Y enter into the determination of expectations about future output.[5] This problem is avoided in those instances where it is appropriate to include policy variables linearly (i.e. independently of KGAP) in the investment equation.

Whatever difficulties we may have in deciding how to interpret b and the W_i in our model, we can be sure that different sizes of b and patterns of W_i could lead to damped or explosive oscillatory movements in the size of the discrepancy between K_t^* and K_{t-1}, and hence in the level of investment.[6] The smaller is b in our

[5]This will not be true if the policy variable also affects the lag distribution relating appropriations and actual expenditures. In this case, there is still a fixed way in which expectations are assumed to be formed about future values of the policy variable, except that it is no longer the same as the way in which past Y_t influences expectations about future output.

[6]For example, assume that $b=1$, $W_2=1$, $W_i=0$, $i\neq 2$, and the system is in equilibrium, with replacement investment always equal to depreciation. In period 0 desired capacity changed by 1.

	New capacity desired (end of period)	Investment
0	1	0
1	1	0
2	0	1
3	-1	1
4	-1	0
5	0	-1

....and so on to infinity

But if b=.5 we get the sequence

0	1	0
1	1	0
2	.5	.5
3	0	.5
4	- .25	.25
5	- .25	0
6	- .125	- .125
7	0	- .125
8	.0625	- .0625

....and the sequence converges rapidly.

Clearly a different structure of W_i is needed to remove the oscillatory pattern, but the smaller value of b leads to a more plausible behaviour pattern. Businessmen do not react immediately to all of an apparent capital shortage; they initiate a few projects and wait to see if the shortage persists.

model, the more likely it is that the model will predict a fairly smooth pattern of investment expenditures in response to a sustained change in K_t^*. If the W_i in each case are representative only of the lags between decisions and actual expenditures, we would expect the b for the M&E equations to be higher than for NRC equations. This is so because the faster depreciation rate on M&E means that the forecasts relevant for M&E investment are shorter term than those on which NRC decisions are based, and hence the relevant M&E output forecasts are more likely to be closely related to current output.

The composition of K_t^* is of course one of the key aspects of the model, for it is on the desired level of capital stock capacity that all the variables of 'neoclassical' investment theory are focused. If one assumes that the level of capital services supplied is proportional to the size of the capital stock,[7] then the desired level of capital services is that at which the marginal productivity of capital is equal to its net rental value; the latter taking into account purchase price, expected life, tax factors, and the firm's internal rate of discount. Working within a production function context, the marginal productivity of capital services can be derived from the level of output. For our initial experimentation, however, given the weakness of our data on the prices of capital and output, the lack of variance in the tax policy series, and our simple lack of knowledge about firms' internal discount rates, we decided to start with a much simpler formulation. We assumed that firms had some desired capital/output ratio, which could be approximated by the formula $\sum_{i=1}^{12} (K/12Y)_{t-i}$ where Y is some measure of the level of output of the economy and K is the capital stock. This implies that over a three year period, if this is long enough to eliminate the cycle, investors are generally satisfied with their capital/output ratios. This historical experience embodies all the tax, price, and discount-rate factors bearing on the desired level of K and assumes that on the average

[7]Jorgenson [14] [15] [17], Hall and Jorgenson [11], Bischoff [2], Resek [23] and others make this assumption in relating the determination of investment to an explicit production function. The validity of the assumption is questioned by Tobin [27], but in the absence of independent utilization data there would seem to be no alternative.

over a long enough period desired capital stock has in the past been equal to actual capital stock. Applying this ratio to the current level of output yields:

$$K^*_t = \sum_{i=1}^{12} (K/12Y)_{t-i} \, (Y_t) \qquad (3)$$

On examining the residuals from our initial experiments, however, we observed that the twelve quarter average appeared to be too short to take in the Canadian business cycle. Longer period movements in output tended to shift the desired capital/output ratio around in a cyclical manner. This being the case, we fitted a trend capital/output ratio by a type of trend-through-peaks approach, leading to:

$$K^*_t = (K/Y)^T \, Y_t \qquad (3')$$

Experimentation with both forms indicated that the latter was clearly superior. This could be because it is not sensitive to the longer cycles; it could also be that by fitting it on a trend-through-peaks we allow historical capital/output ratios to embody the cost-of-capital-services variables that we could not measure explicitly without requiring the assumption that desired capital/output ratios are equal to the average for recent years.

2. *The Measurement of Capital Stock*

The use of the accelerator model rests on the assumption that data exist on the size of the capital stock, since the capital stock at end of last period enters into replacement investment through the rate of depreciation and into capacity-expanding investment through the accelerator term. But, of course, data on the size of the capital stock in Canada on a quarterly basis do not exist. There are estimates of the total stock on an annual basis up to 1955 [13], and for manufacturing [24] up to 1960. Thus, it is necessary to compute stock figures using the quarterly investment flows built onto a base year stock figure. This procedure in turn requires certain assumptions about the length of life of capital assets and the depreciation patterns associated with them.

For a number of reasons, both theoretical and computational,

we chose to use an exponential decay rate depreciation pattern of the form:

$$K_1 = K_0 + I_1 - \rho K_0 \qquad (4)$$

Here I is gross investment, K_0 and K_1 are net capital stocks at the end of periods 0 and 1, and ρ is the rate of depreciation. This form has the advantage that we can use the same measure of capital stock both in our accelerator term KGAP and in our replacement investment term, an equality previously taken on faith. But as Griliches points out ([9] p. 123), replacement investment is equal to the depreciation of the gross capital stock, while the accelerator term depends on the supply of capital services available or on the net capital stock. Only if one uses an exponential depreciation rate is the replacement proportionate to the net stock of capital, so that the same K_t can be used in both parts of the equation.

Further theoretical and empirical support for the exponential rate is marshalled by Jorgenson. (See [17] pp. 139-140.) He cites a theorem in renewal theory to the effect that replacement will be proportional to accumulated capital stock independent of individual equipment replacement patterns provided that the capital stock is constant or is growing at a constant rate — in the probabilistic sense. (See Parzen [21] pp. 180-1 or Feller [8] pp. 285-293.) The latter assumption may be acceptable. In addition, there is the finding of Meyer and Kuh ([19] pp. 91-94) that no significant "echo effect" exists in U.S. investment flows; there is no 'bunching' at regular lagged intervals following high levels of investment.

At the computational level, the exponential rate has the advantage that it can be derived from the flow data and a base period figure by successive application of (4). Thus a stock series for any given ρ can be calculated rapidly by computer, while straight-line assumptions would be more tedious. This is not merely an argument for the easy life; given the present state of our ignorance on the length of life of capital assets it is a significant advantage to have a generating procedure that enables us to search rapidly over a range of possible depreciation rates and to choose that which seems most satisfactory. This, in turn, requires a criterion of choice, and again our model has the advan-

tage of providing such a criterion. It assumes that replacement investment is some proportion c of net capital stock. But replacement investment equals depreciation, which is some proportion ρ of net capital stock. Consequently we need only calculate several stock series for different ρ, plug them into an estimating equation of the form (1), and choose the value of ρ for which the estimated value c and the assumed value ρ converge to equality. This decision rule is of little help if convergence is not observed, but fortunately for us, convergence was found to be regular and quite satisfactory. An acceptable rate for non-residential construction was found quite swiftly, while for machinery and equipment a wider band was searched. Table 1 lists the values of ρ which were tested, together with the depreciated value of an investment of 1 after several terms of years under the various depreciation rates.

This approach, however, has sidestepped the whole question of technical progress. We have assumed above that depreciation means actual physical deterioration; but of course this is not true. Particularly for machinery and equipment there is a constant improvement in the quality of new machines and our capital stock series should take account of this fact. If the value of ρ is assumed to include both physical deterioration and the rate of 'embodied' technical progress, then our net capital stock is a Solow-type 'vintage' capital stock [26] in which capital of different ages is weighted according to its productivity. This is clearly the concept needed in our accelerator term, in which the desired capital stock is related to the level of output. Here, desired capital is actually the desired productive services of capital, and consequently we wish to use a stock series whose components are productivity-weighted. But we face a problem in the replacement term, in that our convergence test now assumes that the faster the rate of technical progress, the faster the rate at which old capital loses value through obsolescence (assuming a constant rate of physical deterioration), and the larger is replacement investment as a proportion of last-period's capital stock. But technical progress implies that less capital is now needed to produce a given level of capital services, so that for given output the value of the capital stock falls. If, for example, output is being held constant, then the faster the value of the capital stock falls (through increased productivity) the larger the proportion of investment which we call 'replacement' invest-

Table 1 Depreciated Value of an Investment of 1, Various Depreciation Rates

Per Quarter	Years							
ρ	5	10	15	20	25	30	50	60
NRC								
.0075	.8606	.7406	.6374	.5485	.4720	.4062	.2228	.1650
.0090	.8346	.6965	.5813	.4851	.4049	.3379	.1639	.1142
.0100	.8180	.6691	.5473	.4477	.3662	.2996	.1341	.0897
.0125	.7778	.6050	.4706	.3660	.2847	.2214	.0811	.0491
M&E								
.0250	.6024	.3629	.2186	.1317	.0793	.0478	.0063	.0023
.0350	.4903	.2404	.1179	.0578	.0283	.0139	.0008	.0002
.0400	.4419	.1953	.0863	.0381	.0168	.0074	.0003	.0001
.0450	.3979	.1583	.0629	.0250	.0099	.0039	.0001	.00002
.0470	.3817	.1457	.0556	.0212	.0080	.0031	.0001	.00001
.0485	.3698	.1368	.0506	.0187	.0069	.0026	.00005	.000007
.0500	.3585	.1285	.0461	.0165	.0059	.0021	.00003	.000004
.0550	.3223	.1039	.0335	.0108	.0035	.0011	.00001	.000001
Maximum Depreciation Rates Permitted Under Canadian Income Tax Laws								
.05 per annum class 3 assets (including most NRC)	.7738	.5988	.4634	.3586	.2775	.2147	.0770	.0461
.20 per annum class 8 assets (including most M&E)	.3277	.1074	.0352	.0115	.0038	.0012	.0000	.0000

ment. It is true that under such circumstances our accelerator variable would be negative and the actual level of net investment would probably also be negative; but what sense can one make of a large positive 'replacement investment' term when the value of the net stock is falling, a term whose coefficient increases the faster is the fall? It is clear that technical progress obscures the meaning of the convergence test which was our primary criterion for the value of ρ.

This problem does not appear to have been faced in the current investment literature, and it tends to leave one in a cleft stick. One can assume that the depreciation rates found by the convergence test are actual physical deterioration, and that technological progress is not significant. Then the appropriate value for capital stock in KGAP would be less than we have assumed due to the increase in productivity which we have assumed away. Moreover one may find that $c = \rho$ for values that are hard to explain on the ground of physical deterioration alone. Alternately one may accept the fact that embodied technological progress takes place, and that our value of ρ is both a deterioration and an obsolescence factor. This removes the bias in capital stock as a component of KGAP but forces us to assume that 'replacement' investment is replacement of both obsolete and worn-out equipment, not up to existing levels but up to some datum capacity level that grows at the same rate as the embodied technical progress rate, such that the dollar value of capital stock is held constant.

In the aggregate, the rate of embodied technological progress is slower than the rate of growth of output, since output is a function of the growing quantities of inputs as well as the increasing (embodied and disembodied) efficiency of capital goods. Thus when we assume 'replacement' investment to be large enough to keep productive capacity growing at a rate equal to the rate of embodied technical progress, we are still leaving a considerable amount of gross investment to be explained by movements of the variables influencing K^*. The corresponding assumption at the level of the firm is that regular gross investment outlays are made in amounts more than sufficient to maintain the productive capacity of the firm's plant but less than required to maintain the firm's share of the growing market. We are, therefore, supposing that decisions to invest so as to maintain a constant share of a growing market are not made automatically (as are the 're-

placement' decisions) but in relation to what is happening in the markets for goods and finance. Whether it is most appropriate to assume that the amount of investment sufficient to increase capacity at a rate equal to the rate of embodied technical progress is the amount of investment not related to recent changes in the incentives to invest, cannot be settled a priori. In principle, there is no reason why all gross investment should not be influenced by the driving variables in the investment equation, but we are never surprised to find that any particular functional form we use in fitting the equation contains a term that is either a fixed constant or a fixed proportion of the lagged capital stock. It is often helpful to regard this fixed proportion as replacement investment, particularly if it helps us to derive an approximate series for the capital stock. One must be careful, however, not to rely too much on the implied distinction between replacement and expansionary investment expenditures.

Whatever decay rate is selected, the above procedure requires that we develop a base year stock from which to build our series. We calculated the bench mark value for both NRC and M&E in 1957 constant dollars, net capital stock as of mid-1949. Since our data set begins in 1947, we have in fact chosen K_{10} and must work back to K_0 and forward to K_{76} for each capital stock series. For manufacturing stock at this date we took Rymes' Set 1 estimates ([24] p. A6) based on the midpoints of the assumed range of "lives". Estimates in index form (1949=100) for most other non-manufacturing industries were published by the Dominion Bureau of Statistics [5]; the absolute numbers for these industries were supplied by the Business Finance Division of D.B.S.

These industries do not, however, include the industrial sector Finance, Insurance, and Real Estate or the Commercial Services subdivision of the service sector. For these, estimates are available in the work of W.C. Hood and A.D. Scott. (See [13] Appendix Table 6B-3, pp. 435-444.) Their estimates are in 1949 dollars, and no adequate deflation method being available we assume that their estimated proportion of industry accounted for by Finance, Insurance and Real Estate and Commercial Services in 1949 could be extended to the D.B.S. data. These two components made up 6.80% of construction-type stock and 3.73% of machinery and equipment. Extending these proportions to our data requires us to assume also that they would apply to the 1957 dollar values as

well; this could be awkward if there have been marked differences between price movements in these sectors and in private industry as a whole. Such differences are unlikely to be large, however, and the smallness of these two sectors makes it improbable that our bench mark could be significantly affected.

The stock bench mark figures are:

Net Capital Stock at Mid-1949
(millions of 1957 dollars)

	NRC	M&E
Manufacturing*	3,785	2,963
Agriculture**	1,206	1,569
Forestry	148	74
Fishing & Trapping	8	94
Mining, Quarrying, & Oil Wells	557	251
Construction	79	255
Transport, Storage & Communication	4,342	1,809
Public Utilities	2,314	680
Trade	1,337	377
Sub-total	13,776	8,072
	(93.20%)	(96.27%)
Finance, Insurance, Real Estate, & Commercial Services	1,005	312
	(6.80%)	(3.73%)
Total	14,781	8,384

* M&E includes $250 million Capital Items Charged to Operating Expenses.

** M&E includes farmers' personal and farm commercial vehicles.

Since the flows cumulated on this bench mark are the National Accounts investment flows, it is clearly desirable that bench mark coverage corresponds to flow coverage. Unfortunately correspondence is not quite exact because D.B.S. stock data are on the Standard Industrial Classification, which differs slightly from the National Accounts basis. The National Accounts basis includes in the personal sector "all private organizations which are not established for the purpose of making a gain, e.g. char-

itable institutions, municipal hospitals, and universities." (See [4] p. 117, para. 98.) Investment by such institutions is included in the Business Gross Fixed Capital Formation category. On the other hand, non-commercial institutions directly administered by any level of government, e.g. municipal schools and federal and provincial hospitals, are included in the government sector. (See [4] p. 135, para. 178.) Investment by such institutions does not enter into the flow series. But capital stock data are not broken down in this manner; the Standard Industrial Classification lumps all such institutions into the Community Services sub-sector no matter which authority administers them. Hood and Scott give one overall stock figure for "Institutions." Allocation by the relative shares of government and non-government institutions in gross investment for 1949 is also impossible, since no breakdown of the National Accounts data is available, and examination of the figures in *Private and Public Investment in Canada* makes it clear that their breakdown of Private Institutions by function does not correspond to the National Accounts division by administering agency. (See [3] any recent year.) Since no juggling of the figures seemed likely to yield a satisfactory split, it appeared best to exclude institutions entirely from the bench mark. The capital in question is very hard to value in terms of its capitalized service production, and new investment is unlikely to be responsive to economic stimuli in any case. It would be preferable to exclude non-commercial institutions from the flow series as well, but existing data do not permit this. Moreover, in terms of the aggregate model, this would simply generate a further and not very important exogenous sector. On balance it is unlikely that this small inconsistency would have any material impact on our estimates.

Closing the model now requires only some specification of the lag pattern in equation (2), again a matter on which we had no a priori information. There are two ways in which a lag pattern can be chosen; either by some maximizing process generating the lags within the model, or by pre-selection of a range of plausible lags and testing of the resulting equation. The first type of approach is exemplified by the Koyck transform and more generally by the Jorgenson rational distributed lag [16], the latter providing considerable flexibility in the final choice of pattern. Such a scheme, however, requires the inclusion in the estimating equation of one or more lagged values of the dependent variable. If the equation residuals are autocorrelated, as the investment series

are, the resulting parameter estimates are particularly unreliable.

In the first place, the coefficients on the independent variables are asymptotically biased as shown by Malinvaud [18]. In addition the standard errors of both the coefficients and the dependent variable are severely understated as shown by the early Monte Carlo tests of Cochrane and Orcutt [6]. Nor can one rely on the standard autocorrelation tests, since the residuals of the fitted equation are not so autocorrelated as the true residuals, making the Durbin/Watson statistic biased towards 2.0. (See Nerlove and Wallis [20].) This problem is apparent in the fitted equation itself, since it has frequently been observed that Canadian quarterly investment functions, including a lagged investment term, yield very good fits with coefficients near 0.9 on lagged investment and very little significance on anything else. We have checked this formulation with a Jorgenson-type lag and confirmed the phenomenon; it therefore appears that no meaningful structure can be located from a quarterly investment equation with a lagged dependent variable.

We therefore fell back on an a priori specification of a range of lags, shown in Table 2 and charted in Appendix B. These lags will hereafter be referred to as labelled in the table. The long lag pattern conforms roughly to the lag between appropriations and expenditures derived by Almon [1] for Total Manufacturing in the U.S., the others are merely attempts to search over a broad band. Early experiments indicated that the PP group of lags involving a two-quarter start-up lag produced markedly inferior results; they were dropped very early on, and no results are reported. It was expected that the machinery and equipment equations would tend to fit better with the shorter lags while the longer lags would produce better results on the non-residential construction accelerator; this is in fact what was found.

The polynomial technique of fitting distributed lags used by Shirley Almon [1] provides an alternative method of deriving lag weights from the equation itself, which avoids both the lagged dependent variable and the use of several highly collinear lagged values of the independent variables. We did not use it for our main analysis largely because the computational capacity to apply the technique became available only late in the project. In addition, our use of seasonally unadjusted data limited the useful-

Table 2 Pre-Specified Lag Patterns Tested

These lag distributions are charted in Appendix B*

Label \ Quarter	t	t-1	t-2	t-3	t-4	t-5	t-6	t-7	t-8	t-9	t-10	t-11
SLAG	0.0	0.25	0.50	0.25								
MLAG	0.0	0.10	0.15	0.30	0.25	0.15	0.05					
LLAG	0.0	0.06	0.11	0.16	0.17	0.16	0.13	0.11	0.07	0.04		
PSLAG	0.0	0.0	0.25	0.50	0.25							
PMLAG	0.0	0.0	0.10	0.15	0.30	0.25	0.15	0.05				
PLLAG	0.0	0.0	0.06	0.11	0.16	0.17	0.16	0.13	0.11	0.07	0.04	
PPSLAG	0.0	0.0	0.0	0.25	0.50	0.25						
PPMLAG	0.0	0.0	0.0	0.10	0.15	0.30	0.25	0.15	0.05			
PPLLAG	0.0	0.0	0.0	0.06	0.11	0.16	0.17	0.16	0.13	0.11	0.07	0.04
JLAG	0.0	0.30	0.35	0.25	0.10							
Poly-nomial NRC	0.03	0.05	0.08	0.10	0.11	0.13	0.13	0.13	0.11	0.09	0.05	
Poly-nomial M&E	0.15	0.21	0.23	0.19	0.14	0.07	0.02	- .01				

* Page 78

ness of the technique, at least for the machinery and equipment equations. By making the seasonal dummies multiplicative with the accelerator term, we have an equation with four separate accelerators, one for each quarter. The polynomial technique uses as regressors linear combinations of the independent variable whose effect is hypothesized to be lagged, and the number of such regressors depends on both the degree of the estimating polynomial and the constraints placed on it. A third- or fourth-degree polynomial would require two or three regressors respectively, which with the seasonal pattern would be eight or twelve. Since there are other terms in the equation besides the accelerator, the number of variables begins to press against the available degrees of freedom.

Polynomial lags were fitted to seasonally adjusted data, using an equation containing only lagged capital stock and the accelerator, to serve as a check on the pre-set lag patterns. The length of lags was set at eight quarters for M&E and eleven for NRC, and the polynomial used was of third degree, equal to zero in periods $t+1$ and $t-n$. The resulting patterns are shown in Table 2, after dividing through by the sum of the polynomial weights to break out the lag pattern alone. As can be seen, the NRC pattern is very close to PLLAG; in fact, an equivalent equation fitted to seasonally adjusted data using the PLLAG pattern was identical with the polynomial equation to the third significant digit. In the case of M&E the polynomial pattern differs somewhat from the predetermined lags and yields a better fit in a simple seasonally adjusted equation — as of course it should. It was therefore carried forward for testing in more complex equation formulations, while the NRC polynomial lag was not. In these later experiments, however, the polynomial lag lost its superiority over the predetermined patterns.

C. Estimation — First Phase

The model embodied in equations (1), (2), and (3) was the initial test vehicle from which information was derived concerning the depreciation rate, the lag structure, and the relevant output measure. The dependent variables throughout this phase were gross investment in non-residential construction (DB 146) [29] and in machinery and equipment in constant 1957 dollars (DB 147), unadjusted for seasonal variation, as reported in the National

Accounts.[8] Because we were working with raw data, our equations had to embody a seasonal adjustment pattern; and it was found after some experimentation that modifications (1') and (1") were most successful for non-residential construction and for machinery and equipment respectively.

$$I_{NRC} = a_1Q_1 + a_2Q_2 + a_3Q_3 + a_4Q_4 + b(KGAP)_t + cK_{t-1} \quad (1')$$

$$I_{M\&E} = a_1Q_1 + a_2Q_2 + a_3Q_3 + a_4Q_4 + b_1Q_1(KGAP)_t + b_2Q_2(KGAP)_t$$

$$+ b_3Q_3(KGAP)_t + b_4Q_4(KGAP)_t + cK_{t-1} \quad (1'')$$

All reported equations are fitted in these forms.

The independent variables at this stage were capital stock series constructed on various depreciation assumptions and output variables in seasonally unadjusted constant dollar terms. For output, two variables were used, Gross National Expenditure (DB 157) and Real Domestic Product less Agriculture. The former is simply the National Accounts series, while the latter was constructed from the index of Real Domestic Product less Agriculture (DB 2565, 1949=100) computed by the D.B.S. Industrial Output Section. By obtaining a single 1957 dollar quarterly output figure from D.B.S. and dividing this by the same quarter index value we were able to derive an expansion factor 43.9472 which when multiplied by the output index yields a constant dollar output series. The RDP series is superior to GNE conceptually in that by excluding the agricultural component it eliminates both a strong and irrele-

[8] The 1965 figures for both NRC and M&E were revised by D.B.S. after being put on Databank. First phase testing as reported in Tables 3 and 4 is with unrevised data, second phase is revised data. The revisions are:

1965	1Q	2Q	3Q	4Q
		NRC		
Old	553	710	951	925
New	576	725	971	924
		M&E		
Old	757	964	861	982
New	783	1,003	905	1,003

vant seasonal and a pronounced year-to-year fluctuation in crop value that is probably not closely related to investment behaviour. Also the Domestic rather than the National basis is clearly superior for an accelerator variable. On the other hand, GNE has as usual the virtue of simplicity and is easy to link with the other equations of a small model. Using RDP commits one to explaining the difference between national and domestic output even if agriculture is simply added as exogenous. We decided to work with both variables as long as possible, as the comparison between the two would be both interesting and useful.

A considerable number of equations were fitted at this stage, and presentation of the significant equations, let alone of all results, would take up more space than it would be worth. Rather than giving the actual equations, Tables 3 and 4 present the important features of each to show the patterns emerging. Thus Table 3 gives the results from fitting (1'), (2), (3), for NRC to three different depreciation rates and a variety of lag patterns, using as output both GNE and RDP less Agriculture. The statistic $\rho - \hat{\rho}$ is the assumed value of the depreciation rate shown at the side of the table, less the calculated value $\hat{\rho}$ or c, the coefficient of K_{t-1}. b is simply the coefficient of the accelerator variable. t-test values are not given; but all variables at this stage were strongly significant with the exception of some of the seasonal constants in the NRC equations. All equations are fitted 1953-1965 using Ordinary Least Squares (OLS).

Table 3 supplies partial answers to three questions. Convergence of ρ and $\hat{\rho}$ for NRC is clearly focused on .01, although the GNE results suggest a rate slightly higher than .01 and the RDP results a rate slightly lower. Examination of the rates of convergence shows that the implied range is between .0090 and .0105 in all cases; given the uncertainty attaching to all such measures the choice of $\rho = .01$ seemed the most reasonable. It is clearly superior to any of the others. Moreover, although three of the RDP results suggest that .01 is somewhat high, the PLLAG result is right on target. By the other criteria in Table 3, RDP is the superior output variable and PLLAG is the superior lag pattern for RDP. Consequently, its performance on the convergence test should carry some extra weight. In addition, similar equations, fitted to seasonally adjusted data using the GNE output measure, gave back calculated values of c within .0005 of .01

All Equations 1953-1965

Table 3 First Tests of NRC $(K^* = \sum_{i=1}^{12} (K/Y)_{t-i}/12)$

Assumed Value of ρ	GNE				RDP ex AG			
	MLAG	LLAG	PMLAG	PLLAG	MLAG	LLAG	PMLAG	PLLAG
				$\rho - \hat{\rho}$				
.0075	-.0011	-.0013	-.0013	-.0017	-.0005	-.0007	-.0007	-.0011
.0100	.0000	-.0002	-.0002	-.0006	+.0007	+.0004	+.0005	.0000
.0125	+.0008	+.0005	+.0006	+.0001	+.0015	+.0012	+.0013	+.0007
				$\bar{R}^2$				
.0075	.697	.702	.705	.703	.716	.729	.731	.735
.0100	.697	.702	.705	.703	.715	.728	.730	.733
.0125	.696	.701	.704	.702	.715	.727	.729	.732
				b				
.0075	.023	.027	.027	.028	.034	.042	.040	.045
.0100	.024	.028	.027	.028	.035	.044	.041	.047
.0125	.024	.029	.028	.029	.036	.045	.042	.048
				D/W				
.0075	.292	.292	.289	.289	.300	.309	.306	.312
.0100	.293	.292	.290	.290	.299	.309	.306	.312
.0125	.294	.293	.291	.290	.299	.308	.306	.312

All Equations 1953-1965

Table 4 First Tests of M&E $\left(K^* = \sum_{i=1}^{12} (K/Y)_{t-i}/12\right)$

Assumed Value of ρ	GNE SLAG	GNE MLAG	GNE PSLAG	GNE POLYNOMIAL	RDP SLAG	RDP MLAG	RDP PSLAG	RDP POLYNOMIAL
				$\rho - \hat{\rho}$				
.045	+.007	+.013	+.009	+.013	+.014	+.020	+.017	+.018
.047	+.003	+.009	+.005	+.009	+.010	+.016	+.013	+.014
.050	-.001	+.001	-.003	+.001	+.002	+.008	+.006	+.005
				$\bar{R}^2$				
.045	.628	.644	.655	.637	.630	.661	.662	.645
.047	.631	.646	.659	.640	.633	.662	.665	.646
.050	.641	.653	.667	.649	.642	.668	.672	.655
				b				
.045	.105	.124	.113	.126	.122	.146	.133	.142
.047	.106	.126	.114	.128	.124	.148	.135	.144
.050	.109	.129	.116	.132	.128	.151	.138	.148
				D/W				
.045	.407	.361	.361	.326	.372	.373	.377	.340
.047	.414	.362	.366	.328	.370	.372	.375	.340
.050	.432	.370	.379	.336	.374	.376	.378	.346

in all cases, being right on .01 several times.

None of the other derived statistics in Table 3 cast much light on the question of the appropriate value of ρ. Clearly, higher values of $\bar{R}^2$ and D/W represent superior equations; in addition higher values of b generally were more significant and were taken as indicative of better performance. This choice reflects a bias on our part in believing that our accelerator tends to underrepresent the reaction coefficient when it is misspecified; but given our small estimates of b, this is probably happening. These three criteria are relatively insensitive to the choice of ρ, and such sensitivity as they do exhibit is conflicting. But the convergence evidence seems sufficiently strong as to justify choosing $\rho = .01$ per quarter as the appropriate rate of depreciation for non-residential construction. This works out to 3.99% per year, or about 80% of the 5% declining balance rate, the maximum rate at which Class 3 buildings may be depreciated for taxation purposes.

The other criteria do give some evidence on the choice of output variable, in that RDP is marginally superior to GNE by every measure for all combinations of ρ and lag patterns. The superiority is not great, but it is gratifyingly consistent. Because of the potential usefulness of GNE in a small aggregate model, and because the margin of superiority is small, it was decided to carry the GNE-based equations forward to the next testing phase as well; but RDP is clearly the preferred output variable.

As for the lag pattern, here the evidence is not quite so clear. The shorter MLAG pattern is slightly inferior by almost all tests; this was confirmed by a number of other experiments which also rejected PSLAG and SLAG quite conclusively. As among the other three, the RDP equations show PLLAG as superior on all tests with PMLAG second when ranked by $\bar{R}^2$, but LLAG second if b or D/W is used. The margin of preference is very very small. With the GNE output variable, the $\bar{R}^2$ test ranks them PMLAG, PLLAG, LLAG, but the other two tests are inconclusive. Other tests, including the seasonally adjusted data using GNE, confirmed this general pattern and the differences are all very small. The polynomial lag calculated from seasonally adjusted data is very close to PLLAG, sufficiently so that no further testing on the polynomial pattern appeared justified. On the basis of this information

PLLAG was accepted as the superior lag, but further tests were done with PMLAG, as well, to provide a check on the results.

We emerge from this phase of experimentation with information on the choice of depreciation rate, lags, and output variables, all more or less in accord with our a priori expectations and with a satisfactory structure on which to build. But our equation fits are not spectacular, and it is clear that much of the $\bar{R}^2$ at this stage comes from picking up the seasonal. Our parallel seasonally adjusted equations gave fits of about 40%. And our pitifully low Durbin/Watson statistics make it clear that a great deal of systematic unexplained variance remains; this is as it should be. We certainly do not expect to explain all the systematic behaviour of investment with a simple output accelerator and would be very suspicious if we did.

The M&E results reported in Table 4 follow much the same pattern as Table 3. The only difference in equation form is that the seasonals now enter multiplicatively with the accelerator variable; an equivalent pattern tested in NRC led to no improvement or even slight deterioration due to loss of degrees of freedom. Thus b for M&E must be calculated as the average of the accelerator coefficients. The convergence test points to a ρ of .050 with the GNE results suggesting a very slightly lower rate and the RDP perhaps a little higher. Again, seasonally adjusted equations confirmed the results derived at this stage. In addition, $\rho = .050$ exhibits slight but consistent superiority on all other tests of the equation, a feature that was not present in the NRC results. Consequently $\rho = .05$ seemed the appropriate choice, leading to an annual rate of 18.65%. This is slightly below the maximum permitted depreciation rate of 20% per year for Class 8 assets.

On the choice of output variables, again RDP is superior. With the exception of the marginally higher D/W for GNE-SLAG, all tests point to RDP over GNE. In general, the margins of superiority are even smaller than for NRC, but they remain consistent. As for the lag pattern, SLAG seems generally inferior. Tests were also run on LLAG, PMLAG, and PLLAG, but they produced significantly worse results. The polynomial pattern is better than SLAG in most respects, but behind PSLAG and MLAG. These results are confirmed in the seasonally adjusted data, except that there, of course, the polynomial lag is better. This is as it should be; after all,

the polynomial lag was derived from seasonally adjusted data. On this basis we decided to use PSLAG and MLAG as our primary experimental pattern but to keep the polynomial pattern on the shelf and to test it out at later stages to see whether it might dominate a more sophisticated equation.

As for the overall quality of these equations, the same general comments apply as to NRC. Here the fit is not quite so good, but it is also less dominated by seasonal factors. The seasonally adjusted equations pick up about 55% to 60% of the variance in this form. It is possible that the seasonal adjustment procedure is removing some systematic components of the error variance.

As mentioned above, the pattern of residuals from testing the accelerator model with K^* defined by equation (3) suggested that the averaging-period was too short. The 'equilibrium' capital/output ratio was shifting with the cycle, reducing the impact of the accelerator at the end of each cyclical phase. Consequently new K^* were defined according to equation (3') based on a trended value of the capital/output ratio. Fitting a linear or log trend was not an adequate method of handling this problem, as it tended to be thrown off by the strong upswing at the end of the data period and by the abnormal conditions prevailing in the early postwar period. For RDP as the output variable a trend-through-peaks method was used in which relative minimum K/Y ratios were identified in 3Q56 and 4Q65. On the assumption that this represented full capacity output, and that desired output was 95% of full capacity, a linear desired K/Y ratio could be fitted through these two points. The ratio of desired output to full capacity output, 95%, is a bit high relative to similar U.S. work — the McGraw-Hill surveys suggest 90% to 92%. (See Phillips [22].) But examination of the series of actual K/Y suggested that 95% was a more reasonable value, and use of a slightly high value covers the possibility that our base quarters do not represent 100% utilization of capacity. Even in those quarters more could have been squeezed out; using a 95% ratio if the actual ratio is 90% implies that in the peak quarters output was only .90/.95 = 94.7% of the absolute maximum possible. The resulting trended K/Y series of course depends on the value of ρ used in constructing the capital stock, but for NRC with $\rho = .01$ the value of K/Y in 4Q49 was 3.214 and the quarterly increments were +.009271. For M&E with $\rho = .05$, the base value was 1.786, and the quarterly increments were

-.005438.[9] Generating a similar series for GNE could not be done by the same sort of trend-through-peaks because K/Y always reaches a minimum in the third quarter due to the agricultural component. Its year-to-year values are heavily dependent on the state of the crops, and the concept of a full capacity output becomes at best dubious. Consequently the trend value was reached by a process of averaging, inspection, and intuition, or lack thereof. The outcome of this process was a base value of 2.590 in 4Q46 for NRC (ρ = .01) and a quarterly increment of +.009524. For M&E (ρ = .05) the corresponding figures are 1.562 and -.004762.

The resulting model, composed of equations (1'), (2), (3') for NRC and (1"), (2), (3') for M&E, was then refitted to the gross investment series from 1953-1965. Since (3') does not require twelve initial quarters for averaging purposes, it would have been possible to cover a broader time period. But comparability suggested that it was preferable to run all equations on the same base period. Lag patterns were restricted to the two best for each class of investment; PMLAG and PLLAG for NRC and PSLAG and MLAG for M&E. The range of depreciation rates was also reduced; M&E was fitted only for ρ = .047 and ρ = .050. For NRC a new series ρ = .009 was generated to compare with ρ = .010.

[9]Calculation of $(K/Y)^T$ $(K/Y)^T$ is calculated by deriving the series (K/Y) from the values of RDP_{XAG} divided into the capital stock used, K_{NRC} and K_{ME}. This yields a series which troughs in 3Q56 and, we assume, in 4Q65. The level of output in these two quarters is assumed to represent full capacity output. It is then assumed that with the existing capital stock, $Y^D = .95Y^F$, and $(K/Y)^D = (K/Y^D)$. Thus we divide K by .95Y for each of the points 3Q56 and 4Q65. These two points on the line $(K/Y)^D$ then allow us to calculate the trend $(K/Y)^T$.

	3Q56	4Q65
Y^F	6,930.47	10,143.01
Y^D	6,583.95	9,635.86
K_{NRC}	22,803.40	36,682.31
K_{ME}	10,792.31	13,856.06
$(K/Y)_{NRC}$	3.464	3.807
$(K/Y)_{ME}$	1.639	1.4379

There are 37 quarters between these peak values, implying rates of change of $\frac{3.807 - 3.464}{37} = +.009270$ for NRC and $\frac{1.4379 - 1.639}{37} = -.005438$ for M&E. Going back 27 quarters to 4Q49, we get a base-quarter value of 3.214 for NRC and 1.786 for M&E; going back a further 12 quarters to 4Q46 we get 3.097 for NRC and 1.851 for M&E.

The results of this set of experiments are given in Table 5, again in test statistic rather than in equation form. In general they confirm our previous results. There is some question concerning the choice of depreciation rate; for M&E the RDP convergence results confirm .050 but the GNE results suggest .047. Since RDP is the preferable output series, this may be taken as net support for .050. Moreover the calculated value of ρ is seen to be more sensitive to the initial choice of ρ in this specification. The other test statistics also give qualified support to our choice, although on $\bar{R}^2$ the pattern is reversed. GNE gives better fits for .050; RDP for .047. The b coefficient is uniformly higher for .050, and the Durbin/Watson statistic is weak all round. For NRC neither value converges well. But all other test statistics support .01 over .009. The margins of choice are uniformly small, but, with some misgivings, .01 was held to be confirmed as the preferred rate.

To the other questions addressed to these data some clear-cut answers are given. The trended K/Y ratio of (3') is clearly superior to the moving average form of (3) and by a large margin. $\bar{R}^2$ rises by .10, or between 1/3 and 1/2 of the residual unexplained variance. The b coefficients are up from 50% to 100%. And even the Durbin/Watson statistics are markedly improved, although the autocorrelation problem is obviously still extreme. We can now substitute (3') for (3) without looking backward.

Moreover, RDP is again superior to GNE on all tests, leading to the conclusion that further experimentation with GNE was unnecessary. In view of its conceptual and experimental superiority, RDP was obviously the variable of choice, and for simultaneous model purposes it would be preferable to derive RDP from GNE with an exogenous agricultural component rather than use the GNE variable in the investment equation. This conclusion was strengthened by preliminary testing of financial variables, which suggested that the RDP form might be more sensitive to their impact than the GNE form. This result in itself is of sufficient importance to lead to the rejection of GNE.

With respect to the lag structure, the picture is less clear. PLLAG is superior to PMLAG by all tests, but never by very much. In view of the accumulation of evidence from the polynomial variables, from seasonally adjusted equations and from these exper-

Table 5 NRC and M&E Tested With $K_t^* = (K/Y)^T\ (Y_t)$

	NRC					M&E			
	GNE		RDP ex AG			GNE		RDP ex AG	
ρ	PMLAG	PLLAG	PMLAG	PLLAG	ρ	PSLAG	MLAG	PSLAG	MLAG
		$\rho - \hat{\rho}$					$\rho - \hat{\rho}$		
.009	-.009	-.011	-.010	-.012	.047	-.002	-.002	+.007	+.007
.010	-.009	-.011	-.010	-.012	.050	-.022	-.023	-.003	-.003
		$\bar{R}^2$					$\bar{R}^2$		
.009	.793	.795	.839	.845	.047	.811	.800	.834	.829
.010	.796	.798	.842	.848	.050	.818	.807	.831	.824
		b					b		
.009	.050	.058	.066	.078	.047	.142	.139	.169	.179
.010	.052	.060	.068	.080	.050	.148	.158	.187	.197
		D/W					D/W		
.009	.380	.388	.468	.501	.047	.555	.506	.593	.576
.010	.387	.394	.477	.511	.050	.638	.537	.589	.576

iments, the margin of superiority is probably enough to justify choosing PLLAG as the optimal structure. It would be nice to be more certain. On M&E, however, we changed our ground somewhat. Observation of the statistics shows PSLAG superior to MLAG on almost all counts, with the strongest superiority in the GNE form. Yet PSLAG has always been a bit worrisome, because it peaks three quarters back. Fifty per cent of the lag weight is concentrated in one quarter. Given the seasonal tendency for M&E investment to peak in the second quarter and output (particularly GNE), to peak in the third, it was possible that PSLAG was picking up points for its seasonal pattern. This led us to choose MLAG over PSLAG. The PSLAG pattern was never a very convincing one a priori in any case. At this point, therefore, a priori prejudice and seasonal misgivings won the day over experimental results — but we tried not to let it happen again.

This experimental phase completes work on the basic model. We now have a structure for both NRC and M&E that can be used for further analysis. Our depreciation rate assumption for NRC may be somewhat low, and that for M&E somewhat high. Our net NRC total stock rises faster than Rymes' NRC stock in manufacturing [24], but then manufacturing makes up a smaller proportion of NRC than of M&E in any case. Also our M&E total stock rises more slowly than Rymes' manufacturing figures [24], but this can be explained by the rising share of manufacturing in total M&E stock as the importance of the railways, for example, declines, and by the fact that our depreciation rate contains an embodied technical progress factor.

The lag patterns chosen, PLLAG for NRC and MLAG for M&E, are comfortably in accord with a priori expectation. The longer NRC construction period means that new plant cannot be provided to meet unexpected short-term changes in demand. Thus we would expect to find a longer, flatter distribution of NRC expenditures behind changes in current output. The relative success of the PLLAG distribution and the low estimated value of b in the NRC equation support these expectations.

On other counts, however, our model is clearly still incomplete. The fits of about 80% of total variance are not bad for investment equations lacking lagged investment; but they are far from spectacular. The gross autocorrelation of the residuals

suggests, first, that our parameter estimates are a lot less significant than our t-tests (all over 2.0) would indicate, and second, that there is plenty of systematic variance left to explain. And finally our equation provides no scope whatever for financial factors, policy variables, or any of the 'interesting' determinants of investment. We have an investment sector that can be influenced only through current output, and then only with long lags.

D. Estimation — Second Phase

The next phase of our work requires the development of more interesting variables of a financial nature and the specification of ways in which they enter the model. Here we would like to capture the impact on investment of interest rates, credit conditions, cash flow, tax provisions, relative goods prices, and all the factors that influence the discounted present value of a stream of future returns. Since the depreciation rates for each class of investment have been selected, explanatory equations are now fitted to net investment calculated by the scheme:

$$I_t^n = I_t^g - \rho K_{t-1} \tag{5}$$

where ρ is .01 for NRC and .05 for M&E. In this way we restrict the coefficient of K_{t-1} to its hypothesized correct value, preventing it from influencing our decisions about other variables. We also reduce the proportion of total variance explained by our basic model, thus giving our new variables more scope in which to play their roles.

There are several specifications possible for a model with new variables added. If we denote F_t as a general financial variable, we could have any of the following forms:

$$(KGAP)_t = \sum_{i=0}^{n} W_i (F_{t-i} K^*_{t-i} - K_{t-i-1}) \tag{6}$$

$$(KGAP)_t = \sum_{i=0}^{n} W_i F_{t-i} (K^*_{t-i} - K_{t-i-1}) \tag{7}$$

$$I_t^n = a + bF_t(KGAP)_t \tag{8}$$

$$I_t^n = a + b(KGAP_t) + d \sum_{j=0}^{m} V_j F_{t-j} \tag{9}$$

where V_j are weights summing up to one that may correspond to the W_i. Clearly (9) includes the case $V_0 = 1$, $V_j = 0$, $(j \neq 0)$, in which F_t enters currently and linearly. Specification (6) implies that the variable affects the desired level of capital services, thus entering directly into the choice of inputs to the implicit production function. In a static, neoclassical world this is the appropriate specification since the level of investment cannot be influenced at any other point. Specifications (7) and (8) imply, on the other hand, that the speed of reaction of investors is sensitive to financial conditions, that their acceptance of a given capital shortage may be faster if 'other conditions' are favourable (specification 7), or that previously initiated projects may be put in place faster (specification 8). Both formulations have the difficulty that $(K_t^* - K_{t-1})$ will frequently be negative, and even KGAP will sometimes be so. In this case, mechanical application of (7) or (8) leads to the sign of $\frac{\partial I^n}{\partial F}$ changing with that of KGAP; this is, of course, wrong. To avoid this problem form (7) and (8) can be fitted with F_t multiplied only by the positive values, in the form:

$$I_t^n = a + b_1(KGAP)_t + b_2F_t(KGAP)_t^+ \tag{8'}$$

The idea that investors only react to financial conditions when desired net investment is positive is a plausible sort of formulation.

Forms (6), (7), and (8) strongly suggest also that variables be used in some sort of index form based around one; this is necessary in (6) and desirable in (7) and (8) to avoid changing the value of b. If the reaction coefficient changes over the cycle, its long run value should not be influenced by F_t. This will only be true of our equations if the long run value of F_t is one, and if F_t and KGAP are uncorrelated. Finally form (9) im-

plies that a variable is influential in the investment process, either at the stage of initiation or at the stage of completion of projects, or somewhere in between (depending on the time-shape of the V_j), but its impact could not be captured in a theoretically satisfactory manner. Its correct specification has not been found, and the linear form gives a reasonable approximation. This is obviously preferable to excluding the variable. Several different specifications were used for V_j. Both NRC and M&E were tested with linear variables entering currently, then with lags equal to those used on the accelerator term — PLLAG and MLAG respectively. In addition, an intermediate J-lag was used, with weights 0.0, 0.30, 0.35, 0.25, 0.10, for both classes of investment. Finally some M&E specifications were also tested with the M&E polynomial lag shown in Table 2.

The general variable F_t was given content in several different forms, both singly and in combination. In each case, efforts were made to assess the role a given variable played in the equation, since it was recognized that each variable could have several meanings. The variables used were: cash flow ratio (CFR), the industrial bond yield (IBY), the industrial bond index (IBI), which is simply a ratio of moving average to current values of the form:

$$IBI = \sum_{i=1}^{12} IBY_{t-i}/12IBY_t \qquad (10)$$

the average yield on government securities (10BY) of over 10 years to maturity, the government bond index (10BI), the yield on a group of selected equities (EY), the equity index (EI) calculated as in (10), the bond/equity variable (BEY), which is a weighted average of IBY and EY, the bond/equity index (BEI), the stock price index (SI), and the current and future policy variables (CPV, FPV).

CFR is calculated from the sum of corporate retained earnings and depreciation allowances (DB 1393, DB 3711), deflated by the ratio of current dollar to constant dollar business spending on plant and equipment. The current dollar series are (DB 215 and DB 216). This cash flow series is fitted to a linear trend from 1950 to 1965, and the CFR is the ratio of current to trend value.

CFR is intended to represent an availability constraint on investment, based on the commonplace that internal funds have a lower marginal cost to the firm than external funds. Its influence is not clear-cut, however, because cash flow and profits are highly correlated, and CFR could play a strong expectational role. The roles of IBY, IBI, 10BY, and 10BI are fairly clear-cut. They are intended to represent the marginal cost of external debt finance. But both IBY (which is the McLeod, Young, Weir index of ten industrial bonds (DB 268)), and 10BY, (the average yield on government bonds of over ten years to maturity (DB 2764)), have substantial trend components. The latter series is clearly a less adequate representation of the marginal cost of external debt finance to the private sector (both of course are inadequate in that they represent average rather than marginal costs), but it has the advantage of being the long rate generated elsewhere in the simultaneous econometric model. 10BY should enter our equations in a manner parallel to IBY, but less significantly. IBI and 10BI both eliminate any trend in interest rates, but they are relative rather than absolute cost factors. This may be appropriate since $(K/Y)^T$ should reflect trends in finance costs. The present cost of finance relative to its recent values might influence the speed of business reaction; presumably it should not influence K_t^* directly in the form of (6). An interest index that was picking up cyclical expectation factors might enter as in specification (6); but in this case favourable expectations would be associated with high current interest rates and low values of the interest index, and would have a lower value of K_t^* after multiplication by the index. Thus there is no danger of expectations effects masquerading as cost effects in this specification; the two would have the opposite effect in the equation, and a strongly expectational interest index, used as in specification (6), would wreck the accelerator term.

Variables EY, EI, and SI are meant to represent compounds of cost and expectation factors. EY is the Moss, Lawson ratio of latest declared dividend at annual rates to current stock price for 114 stocks (DB 2765); SI is the D.B.S. Index of Industrial Common Stocks (DB 2597), fitted to a log trend from 1946 to 1965 and then taken as ratio to trend. SI should represent purely expectational factors. This variable compared with EY or EI can suggest whether the equity yield is playing an expectational or a cost-of-funds role, which is useful because IBY and EY jointly

may represent a closer approximation to the marginal cost of funds than does either one alone. On the other hand, an equity yield stronger than the bond yield suggests an expectational role that can be confirmed by SI. This type of combination is embodied in BEY, which is a quarterly series combining EY and IBY with weights equal to their proportionate shares in gross corporate new issues. This variable should play a cost role, but separate examination of IBY and EY is necessary to ensure that it is not dominated by an expectational equity yield. Finally, CPV and FPV were calculated to show the influence of the government's changes in depreciation provisions and in the sales tax on construction materials and machinery and equipment. CPV calculates the present value of depreciation provisions relative to 1Q51, adjusting for percentage changes in the price of capital goods due to the sales tax. The index is intended to parallel price effects, rising as the value of depreciation provisions falls. FPV is the expected value of CPV eighteen months hence on the naive assumption that investors believe what the government tells them. It is expected to enter the determination of b in ratio to CPV, while CPV should enter the determination of K^*. The derivation of the two variables is described in Appendix A.

At this stage the empirical results for NRC and M&E begin to diverge, as it becomes clear that different variables and different specifications are relevant to the two classes of investment. Consequently, reporting of the experimental results has been split, and NRC and M&E have been dealt with separately.

1. Non-Residential Construction

In this section we shall discuss the outcome of the NRC experiments, some of which are presented in Tables 6 to 9.

Tables 6 and 7 are largely unsatisfactory efforts to use a linear form for NRC. All the variables tested are strongly significant, but they are, in general, wrongly signed. The cash flow ratio has the correct sign and is significant throughout, but tends to weaken the accelerator coefficient substantially. In current form, CFR does not lead to a strong fit, though it does have the desirable property of small and mostly insignificant seasonals. Shifting CFR to a PLLAG structure strongly increases

Table 6 Net NRC with Financial Variables Linear and Current

KGAP is PLLAG

Q1	Q2	Q3	Q4	KGAP	CFR	IBY	BEY	EY	SEE	$\bar{R}^2$	D/W
- 66.73	6.26	163.53	106.89	.028	326.81				73.6	.729	0.35
(0.61)	(0.05)	(1.20)	(0.86)	(2.75)	(2.71)						
-271.47	-118.27	26.16	- 72.44	.070		104.43			56.0	.843	0.63
(3.63)	(1.58)	(0.34)	(0.94)	(8.04)		(6.77)					
-282.62	-126.89	20.97	- 81.09	.052			106.10		65.6	.784	0.49
(2.53)	(1.14)	(0.19)	(0.71)	(5.72)			(4.59)				
- 0.27	149.00	288.75	197.83	.086		107.48		-58.13	52.0	.864	0.72
(0.00)	(1.29)	(2.52)	(1.69)	(8.80)		(7.49)		(2.90)			
-608.80	-546.19	-395.29	-455.46	.061	363.62	107.91			46.1	.894	0.90
(6.52)	(5.04)	(3.67)	(4.47)	(8.24)	(4.80)	(8.50)					
-746.80	-698.73	-543.45	-601.17	.042	433.21		123.33		53.9	.854	0.84
(5.60)	(4.66)	(3.64)	(4.19)	(5.46)	(4.81)		(6.38)				
-474.33	-402.22	-253.73	-315.84	.068	320.03	108.55		-20.15	46.1	.893	0.87
(2.85)	(2.20)	(1.41)	(1.80)	(6.75)	(3.64)	(8.53)		(0.98)			

Table 7 Net NRC With Financial Variables Linear and PLLAG

KGAP is PLLAG

Q1	Q2	Q3	Q4	KGAP	CFR	IBY	EY	BEY	SI	SEE	$\bar{R}^2$	D/W
-649.91	-498.38	-347.10	-440.57	.011	849.42					49.7	.876	0.69
(6.21)	(4.75)	(3.31)	(4.19)	(1.60)	(8.42)							
-108.00	42.32	192.52	97.91	.070		73.54				74.2	.724	0.37
(.81)	(.32)	(1.43)	(.72)	(4.30)		(2.52)						
252.44	406.97	558.26	466.99	.035				- 6.62		79.2	.686	0.31
(1.09)	(1.75)	(2.40)	(2.00)	(2.30)				(.13)				
1,039.92	1,187.95	1,336.89	1,241.20	.084		14.02	-175.45			46.3	.892	0.91
(6.60)	(7.53)	(8.47)	(7.85)	(8.18)		(.72)	(8.57)					
-693.00	-542.28	-391.25	-485.37	.020	818.48	16.69				49.9	.875	0.70
(5.86)	(4.56)	(3.28)	(4.05)	(1.54)	(7.54)	(.79)						
-590.46	-438.60	-287.25	-380.47	.008	850.46			-13.03		50.1	.874	0.69
(3.32)	(2.46)	(1.61)	(2.12)	(.81)	(8.35)			(.42)				
335.14	484.16	633.98	538.92	.052	444.61	3.21	-116.30			40.6	.917	1.13
(1.45)	(2.10)	(2.75)	(2.34)	(4.22)	(3.81)	(.19)	(4.90)					
-256.26	- 99.51	51.83	- 37.51	.013					440.02	72.8	.735	0.37
(1.55)	(.60)	(.31)	(.23)	(1.09)					(2.91)			
-617.79	-466.70	-315.43	-409.26	.014	882.39				-60.72	50.1	.874	0.69
(4.96)	(3.75)	(2.54)	(3.30)	(1.60)	(7.21)				(.49)			
-671.83	-521.25	-370.20	-464.44	.020	838.81	14.94			-31.46	50.4	.873	0.70
(4.50)	(3.48)	(2.47)	(3.10)	(1.54)	(6.01)	(.66)			(.24)			

its significance and picks up over fifty per cent of the residual variance. On the other hand, KGAP is nearly wiped out and the seasonals rise sharply. The cash flow ratio clearly plays a strong role, although in this form it weakens our model. The great improvement achieved with CFR PLLAG suggests that non-residential construction programmes tend to be relatively inflexible once initiated and that the financial climate when the capital shortage occurs is much more influential on the investment later put in place than are subsequent conditions. This holds whether CFR plays an expectations or a cash flow restraint role and is in line with a priori expectation.

As for the financial variables tested, IBY is wrongly signed in all equations. In current form it adds strongly to the power of the equation, though with the wrong sign. It is not clear how this should be interpreted, whether it is acting as an activity proxy or whether the causal sequence is reversed — high levels of building driving up interest rates. Yet if CFR is a cash flow variable and operates with a lag, this implies that projects are financed when initiated, not on a pay-as-you-go basis. This is much more plausible, but then why are current rates so strongly correlated and lagged rates generally less so? In any case it is clear that the appropriate interest cost variable has not been found. The current bond/equity variable BEY is off as badly as IBY wherever it is used and the same pattern recurs. For EY, however, the sign is correct in current form and strongly correct in lagged form. Since it diverges from the behaviour of IBY, EY is probably exhibiting its expectations variable aspect. When EY is combined with CFR and IBY, all PLLAG, the latter drops out entirely and CFR loses much of its weight. Also the accelerator coefficient recovers substantially. This combination (with IBY excluded) is probably the optimal linear equation for NRC. All equations were run with linear variables in a JLAG format as well;[10] this gave results part way between current and PLLAG, as expected. JLAG CFR was better than current, but worse than PLLAG, and the interest and equity variables were also intermediate.

An interesting aspect of the expectations problem is brought out by the use of the stock index PLLAG in Table 7. By itself,

[10]See Table 2.

this variable is correctly signed, but it adds little to the value of the equation and knocks out the accelerator term. In conjunction with CFR, however, it is, in turn, knocked out. The equity yield EY does not drop out in this way; on the contrary it adds greatly to the power of the equation. When EY is added to IBY, $\bar{R}^2$ rises from .724 to .892 and, even when CFR is included, $\bar{R}^2$ rises from .875 to .917. Thus it appears that EY is superior to SI as an expectations index. Perhaps this is so partly because SI is a stock price index, while EY is a ratio of dividends to stock prices. EY thus abstracts from the variance of stock prices the amount related to the variance of current dividends, leaving perhaps a purer measure of optimism or pessimism about the future.

Thus we strongly suspect that CFR is behaving like an expectations variable rather than a cash flow constraint variable. This is interesting when compared with the statement by Michael Evans ([7] p. 152) that: "Profit-type variables are more important as flow-of-funds variables rather than as expectations variables. Thus lagged rather than present values are more relevant in explaining investment...." With the second half of the statement, we obviously concur. But does it really follow from the first half? Our results show CFR and EY competing for explanatory power. If CFR is not expectational, what is EY? Do we hypothesize that most new construction is financed by equity issue, hence the irrelevance of IBY? We would rather not.

Since CFR appears to exhibit its main impact at the point of initiation of investment projects, and so to be most influential with a long lag, it was tested directly on K_t^* as in formulation (6). This implies that desired capital stock is a function of the long run factors embodied in the trend capital/output ratio, the present level of output, and expectations about future output embodied in the CFR. As can be seen in Table 8, the equation in this form is greatly superior to current CFR and only somewhat inferior to the lagged linear CFR. The coefficient on KGAP gains greatly in significance, but decreases in size, reflecting a substantial increase in the fluctuations of the KGAP variable. When further linear variables were added, this accelerator coefficient displayed remarkable stability, moving within a range of one standard error.

The bond yield, when added lagged to this format, is insig-

Table 8 Net NRC $K^* = (CFR)\ (K/Y)^T (Y)$, Financial Variables Linear and PLLAG. KGAP is PLLAG

Q1	Q2	Q3	Q4	KGAP	IBI	IBY	EY	EI	10BI	t	SI	SEE	$\bar{R}^2$	D/W
217.56 (13.40)	369.15 (22.91)	521.08 (32.24)	427.90 (26.61)	.026 (8.26)								56.7	.839	0.53
-308.97 (3.23)	-158.42 (1.65)	- 7.12 (.07)	-101.58 (1.06)	.029 (11.30)	548.90 (5.55)							44.4	.901	0.84
772.40 (5.03)	922.30 (5.99)	1,072.74 (6.98)	978.56 (6.35)	.027 (9.38)		-14.95 (.96)	-100.27 (5.21)					42.4	.910	0.99
-138.22 (1.56)	14.54 (.16)	167.39 (1.88)	72.46 (.81)	.026 (9.11)					376.08 (4.09)			49.6	.879	0.69
-244.52 (3.07)	- 94.92 (1.19)	56.45 (.71)	- 41.11 (.51)	.033 (14.78)	393.72 (4.45)					1.97 (4.97)		36.4	.935	1.28
-325.02 (2.01)	-172.85 (1.07)	- 20.05 (.12)	-115.44 (.72)	.029 (7.17)	560.41 (5.47)						11.94 (.11)	45.3	.899	0.83
208.43 (1.25)	359.45 (2.16)	511.45 (3.08)	415.58 (2.50)	.030 (13.00)	319.25 (2.87)		- 60.54 (3.65)					39.8	.922	1.11
- 92.11 (.76)	58.78 (.48)	210.91 (1.74)	113.85 (.94)	.031 (12.29)	707.67 (6.47)			-339.37 (2.71)				42.0	.913	0.94
TQ1	TQ2	TQ3	TQ4											
- 1.21 (2.80)	1.71 (4.04)	4.55 (10.89)	2.78 (6.81)	.0322 (14.58)	303.61 (15.06)							36.2	.936	1.33
- .90 (2.15)	2.02 (4.96)	4.86 (12.06)	3.09 (7.83)	.0307 (13.70)					290.13 (14.94)	Final Equation OLS		36.4	.935	1.31

nificant; while the equity yield has a strong negative sign and helps the equation considerably. Most notably, however, the bond index PLLAG has the correct sign and is strongly significant. The significance of the bond index PLLAG is unaffected by the addition of the stock index and only partially reduced by the equity yield. It is possible that a genuine cost-of-funds impact has been isolated. The performance of 10BI relative to that of IBI provides further evidence of a cost-of-funds role. A cost-of-funds argument would require 10BI to behave similarly to IBI but not so well, because presumably 10BI is a less appropriate measure of the true cost of finance to the firm. If instead IBI picks up expectational factors, nothing much can be said about the reaction of IBI and 10BI. In fact we find that 10BI is similar to IBI but raises the $\bar{R}^2$ less, has a lower coefficient, and is slightly less significant. These results are far from 'proof' of the cost-of-funds hypothesis, but at least they fail to contradict it.

One further suggestive feature of the linear results is the strong performance of the trend term, a factor whose importance was clear from the residuals. By itself, the existence of such a trend is a rather puzzling feature. In conjunction with the seasonals, however, the trend performs even better, and the significance of the other variables is greatly increased. That the size of the seasonal dummies should grow over time with the growth in NRC investment is a much more plausible feature. The trend is fitted from 1947 to 1965; this means that the rate of increase over the regression period (1953-65) is lower than it would be if the trend began in 1953.

This procedure yields our final equation and enables us to finish with a very reasonable result. The fit is better than any previous results, and all coefficients are strongly significant. The cash flow variable enters directly into the determination of the desired capital stock, suggesting an expectational role; but the bond index appears to be playing a cost or constraint role, and this is what we should want it to do. Both variables enter only with the same lag as the accelerator variable, suggesting that, once initiated, construction projects are not very flexible and do not respond much to more current conditions. Another encouraging note is that the Durbin/Watson statistic is up sharply over all previous experiments. It is even possible at this level that autocorrelation is not present, though a look at the resid-

uals makes this a bit doubtful. In any case autocorrelation is not nearly so severe a problem as it has been throughout our earlier experiments.

Breaking out the relationship between the interest rate and the quarterly investment level requires one to pass through two lag structures. The level of investment follows the bond index with a PLLAG pattern, and the index depends on the current and past twelve quarters' interest rates. The mean values of I^n_{NRC} and I^g_{NRC} are $357 million and $626 million over the period 1953-65. IBI and 10BI have means of .9661 and .9506. Their respective coefficients are 303.61 and 290.13, leading to long run elasticities of net investment of .82 and .77, and gross investment of .46 and .44. These elasticities are with respect to changes in the bond indices and take eleven quarters to work through. The instantaneous elasticity of a change in the index is, of course, 0, while the maximum response in any one quarter of I^n_{NRC} to a maintained change of 1% in the IBI is .14%.

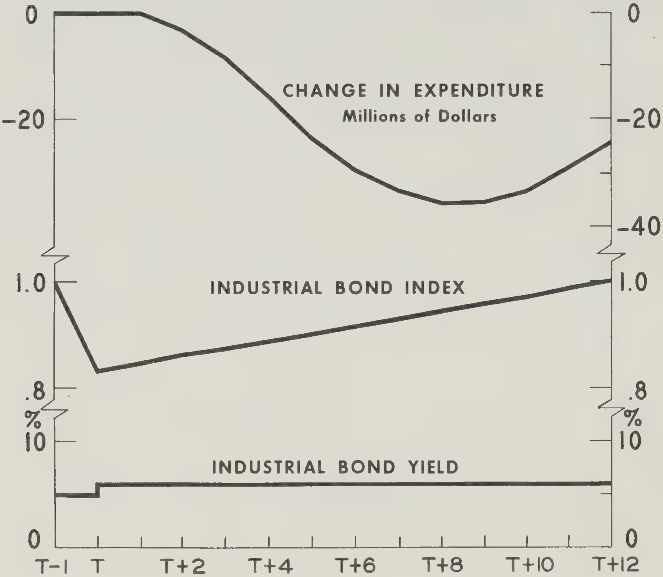
To show how a change in the interest rate would work through the index to affect net investment, we have hypothesized an initial n-period equilibrium with IBY = 5% with a change to 6% in period t maintained in all subsequent quarters. The time pattern of response is shown in Chart 1, page 42.

The accumulated reduction in gross NRC expenditures is $272 million by the end of twelve quarters. Of course, one would expect multiplier effects on Y to change this pattern of response, but this would require a simultaneous model. The impact on quarterly investment is falling, though still substantial. Thus the long bond rate operates with substantial lags and with no particular force in any one quarter.

Table 9 represents the outcome of experimentation with our policy variables, as well as with a slightly different model that did not work out. The first two equations represent the final equation from Table 8 with K* multiplied by 100/CPV, and in the second case, with FPV/CPV multiplied by the positive values of $(K^*_t - K_{t-1})$ before the weighting pattern is applied. As can be seen, the use of CPV alone has almost no effect on the equation; use of FPV and CPV together weakens the other coefficients, although adding to both $\overline{R}^2$ and D/W. Unfortunately, not much

Chart 1

REDUCTION IN GROSS NON-RESIDENTIAL CONSTRUCTION EXPENDITURE IN RESPONSE TO A 1% INCREASE IN THE INDUSTRIAL BOND YIELD



significance can be read into this result since the raw correlation between KGAP and KGAP+ FPV is .9474. There has not really been enough variation in tax policy for our CPV and FPV variables to show themselves over the relevant data period.

The last two equations are run on a model designed to evade the problem of the negative KGAP. Here the dependent variable is gross investment, and the initial model is broken up thus:

$$KGAP = \sum_{i=0}^{n} W_i (K^*_{t-i} - K_{t-i-1} + \rho K_{t-i-1})$$

This implies that depreciation investment is not an automatic factor entering currently and equal to the amount of capital

Table 9 NRC PLLAG Other Specifications

Dependent Variable is Net NRC

TQ1	TQ2	TQ3	TQ4	KGAP with $\frac{100}{CPV} K^*$	IBI	$KGAP^+$ with $\frac{FPV}{CPV}(K^* - K_{t-1})$	SEE	$\bar{R}^2$	D/W
- 1.36 (3.06)	1.58 (3.66)	4.44 (10.39)	2.69 (6.42)	.032 (14.08)	316.32 (15.22)		37.3	.932	1.28
- 1.85 (3.77)	1.15 (2.46)	3.99 (8.56)	2.25 (4.95)	.016 (1.91)	285.50 (11.41)	.0003 (2.06)	36.0	.936	1.37

Dependent Variable is Gross NRC

Q1	Q2	Q3	Q4	KGAP1	KGAP2	KGAP1 with CFR	KGAP2 with CFR	SEE	$\bar{R}^2$	D/W
-20.04 (.37)	127.87 (2.32)	278.04 (5.00)	181.23 (3.20)	.084 (6.98)	.063 (5.88)			64.9	.830	0.45
- 7.01 (.21)	144.79 (4.22)	295.18 (8.52)	196.28 (5.55)			.064 (8.72)	.043 (6.41)	45.9	.915	0.86

stock worn out; but rather is to be treated symmetrically with capacity-expanding investment. It will be subject to the same lag structure and the same elasticity of expectations considerations. Breaking up the equation:

$$\mathrm{KGAP} = \sum_{i=0}^{n} W_i K^{*}_{t-i} + \sum_{i=0}^{n} W_i(\rho - 1)K_{t-i-1}$$

$$\equiv \mathrm{KGAP1} + \mathrm{KGAP2}$$

Clearly the coefficient of KGAP2 should be (ρ - 1) times that of KGAP1 and both can be multiplied by any term whose influence is to be exerted on the speed of reaction. Unfortunately, as can be seen from the table, this model is most inadequate. The coefficient on KGAP2 is wrongly signed and is too small relative to KGAP1. Moreover, the raw correlation between the two is -.9874, which may go some distance toward explaining the unsatisfactory structure. It appears that, while work in this direction might be interesting and useful, some way around the collinearity problem would have to be found. And that is another paper.

2. Machinery and Equipment

The results for machinery and equipment are somewhat mixed, as shown in Table 10. The first seven equations in the table represent efforts to include current linear variables, and of these only CFR produces the correct sign with both significance and explanatory power. The IBY and the BEY have no significance, and IBY has the wrong sign; in conjunction with EY, IBY becomes correctly signed but is still insignificant. The substantially stronger performance of EY strongly suggests that this variable is expectational and is unconnected with the cost of funds. Both these indications are confirmed when the CFR is included in the equations; IBY becomes slightly larger and positive, and EY loses significance. None of these variables add anything to CFR in the current form.

When some variables were tested with the JLAG (0.0, 0.30, 0.35, 0.25, 0.10), the interest rate variables gained in sign and significance. Results are reported only for CFR and BEY, but, in

Table 10 Net M&E. Financial Variables are Linear, Current Equations 1 to 7 and JLAG Equations 8 to 10. KGAP is MLAG

Q1	Q2	Q3	Q4	Q1KGAP	Q2KGAP	Q3KGAP	Q4KGAP	CFR	IBY	BEY	EY	b	SEE	$\bar{R}^2$	D/W
-283.51	-221.31	-358.44	-319.08	.142	.136	.124	.174	385.0	(final phase two equation OLS)			.144	44.0	.840	0.73
(4.65)	(2.83)	(4.68)	(4.58)	(4.78)	(4.62)	(4.47)	(6.38)	(5.52)							
156.23	317.67	148.16	188.98	.187	.201	.154	.213		1.36			.188	50.8	.764	0.58
(2.33)	(4.70)	(2.16)	(2.68)	(4.68)	(5.05)	(3.95)	(5.58)		(.12)						
203.41	365.69	196.39	239.40	.188	.204	.157	.217			- 8.06		.191	50.7	.765	0.58
(2.21)	(3.92)	(2.12)	(2.46)	(4.72)	(5.09)	(4.02)	(5.61)			(.47)					
426.11	579.67	400.04	458.41	.214	.221	.164	.237		- 9.50		-42.16	.209	47.9	.790	0.60
(3.42)	(4.75)	(3.36)	(3.64)	(5.47)	(5.76)	(4.43)	(6.36)		(.80)		(2.51)				
-240.18	-171.30	-330.66	-258.18	.174	.175	.143	.195	367.38	16.27			.172	42.1	.853	0.79
(2.52)	(1.53)	(3.03)	(2.45)	(5.20)	(5.18)	(4.40)	(6.08)	(5.21)	(1.61)						
-271.15	-204.72	-360.57	-291.72	.171	.171	.143	.191	373.70		21.63		.169	42.5	.851	0.82
(2.21)	(1.46)	(2.65)	(2.17)	(5.05)	(4.92)	(4.34)	(5.74)	(5.07)		(1.38)					
-127.51	- 53.55	-217.42	-141.75	.184	.184	.147	.205	340.12	11.85		-12.91	.180	42.3	.852	0.76
(.74)	(.78)	(1.20)	(.78)	(5.11)	(5.14)	(4.45)	(5.95)	(4.31)	(1.02)		(.78)				
-113.29	60.93	-111.32	- 83.55	.165	.179	.128	.187	255.80				.164	46.1	.806	0.69
(1.19)	(.67)	(1.22)	(.87)	(4.48)	(4.85)	(3.55)	(5.29)	(3.04)							
396.63	559.26	391.16	433.20	.187	.202	.156	.216			-47.91		.190	46.7	.800	0.65
(4.48)	(6.30)	(4.42)	(4.84)	(5.08)	(5.50)	(4.38)	(6.19)			(2.79)					
115.84	287.79	117.07	148.75	.170	.184	.136	.196	194.88		-33.51		.171	44.7	.817	0.73
(.76)	(1.93)	(.78)	(.97)	(4.73)	(5.13)	(3.84)	(5.64)	(2.22)		(1.89)					

general, equations on IBY and IBY plus EY were similar. Both variables had correct signs, roughly equal coefficients with IBY slightly larger, and coefficients summing to a value a little larger (absolutely) than the coefficient of BEY. For the most part, the significance of the individual coefficients was slightly lower than the significance of BEY.

This generally good picture is marred by a problem made apparent if CFR JLAG is compared with CFR current, the latter being obviously much superior. The coefficient is larger, the t value is greater, and the $\bar{R}^2$ is up. Thus IBY and EY have produced their good results only when included with a less satisfactory CFR variable. Since it is clear that current CFR is the correct variable, we have to move to estimation of our linear variables with various lags in conjunction with the current CFR. Some results from this procedure are shown in Table 11.

The variables employed in this test were IBY, EY, BEY, IBI, EI, and BEI, all entering both currently and with MLAG, while CFR was entered currently. In addition, a trend term was entered to parallel the NRC results. From these regressions, all but the four reported in Table 11 produced wrong a priori signs and/or insignificant coefficients on the financial variables. The trend variable was completely insignificant. Of the current variables, only the expectational impact of EY, EI, and SI was picked up, and, as can be seen, the inferiority of SI as an expectational index was confirmed. EY had the correct sign; EI was even better and greatly strengthened the accelerator coefficients. But the impact of EI grows at the expense of the CFR, confirming the expectational role of the latter. Best fit of all and a marked reduction in autocorrelation were achieved by using both EI and IBI currently; but unfortunately the strong negative coefficient of the latter makes this unacceptable.

Efforts to include the financial variables with a MLAG pattern were uniformly unsuccessful. All were insignificant, even the strong EI whose coefficient went almost to zero and took on the wrong sign. This seems a clear indication that financial variables at the point of project initiation are much less important to M&E investment. Presumably such investment programmes are much more flexible and thus respond strongly to current expectations as embodied in CFR or EI. Financial constraints do not

Table 11 Net M&E on CFR Current and Other Current Linear Variables. KGAP is MLAG.

Q1	Q2	Q3	Q4	Q1KGAP	Q2KGAP	Q3KGAP	Q4KGAP	Current Financial Variables			b	SEE	$\bar{R}^2$	D/W
								CFR	EY					
6.06	88.79	- 77.32	- .34	.192	.193	.154	.215	304.99	-21.13		.179	42.4	.852	0.72
(0.05)	(0.70)	(0.65)	(0.00)	(5.46)	(5.55)	(4.74)	(6.53)	(4.29)	(1.46)					
									SI					
-133.89	- 45.78	-204.19	-135.10	.178	.182	.151	.206	293.06	42.04		.181	43.3	.845	0.73
(1.95)	(0.53)	(2.52)	(1.78)	(5.17)	(5.25)	(4.55)	(6.22)	(2.61)	(0.48)					
									EI					
-247.28	-149.23	-327.67	-241.93	.228	.226	.175	.250	231.82	235.48		.220	40.5	.865	0.77
(3.13)	(1.68)	(3.67)	(2.94)	(5.99)	(6.11)	(5.38)	(7.00)	(3.01)	(2.51)					
										IBI				
- 45.84	73.95	-126.84	- 32.00	.254	.245	.172	.267	129.70	424.25	-301.43	.235	35.2	.898	1.16
(0.53)	(0.76)	(1.35)	(0.35)	(7.51)	(7.53)	(6.07)	(8.52)	(1.80)	(4.45)	(3.82)				
										BEY MLAG				
-207.25	-137.22	-294.12	-220.32	.177	.180	.150	.203	366.73		10.67	.178	43.3	.845	0.76
(1.09)	(0.64)	(1.39)	(1.08)	(5.15)	(5.19)	(4.54)	(6.20)	(3.69)		(0.44)				
										BEY JLAG				
-169.34	- 95.02	-252.41	-179.98	.176	.179	.149	.202	351.53		5.36	.177	43.4	.845	0.75
(0.94)	(0.46)	(1.26)	(0.93)	(5.08)	(5.10)	(4.48)	(6.09)	(3.64)		(0.24)				

seem to be significant at either end of the process. Tests were also run with the JLAG pattern on the financial variables; but these were also of no help. Table 11 gives two of the equations, both with KGAP in MLAG, CFR in currently, and BEY in as MLAG and as JLAG. As can be seen BEY has the wrong sign and contributes nothing to the equation. This behaviour was general for the financial variables with either lag pattern.

Efforts were also made to include the financial variables multiplicatively, but this was not successful. Carrying the CFR into K^*, as had been done for NRC, was a complete failure; the average b coefficient was reduced by one-third, the $\bar{R}^2$ dropped below .60, and the Durbin/Watson was halved. Even so, the accelerator remained significant; but it was clear that this form could not be used. This is at least a consistent result; our linear experiments have shown the strong superiority of current over lagged CFR. Efforts to bring in the CFR multiplicatively with KGAP or with $(K^*_{t-i} - K_{t-i-1})$ were thwarted by the prevalence of negative terms, to be expected in total M&E, since the stock of such capital is growing less rapidly than NRC. Here the implications of our required assumptions about embodied technical progress may be returning to trouble us. A possible solution to this problem, unfortunately not considered until the experimentation was completed, would be to use the reciprocal of CFR multiplicatively with KGAP. It is possible that such a manoeuvre would set up the type of breakthrough achieved in NRC with CFR multiplied by K^*, but it is not necessarily so. The strong positive associations between present financial conditions and M&E investment, combined with their complete impotence in lagged form, would be quite hard to reverse. The only helpful linear variable is the current equity yield, which apparently captures some aspect of expectations formation that the CFR does not. But this variable is hardly useful as a predictive tool. Thus the best equation appears to be simply the accelerator model with the current CFR, explicitly admitting that M&E investment is pretty responsive to current conditions but insensitive to most financial considerations.

An effort was also made to insert variables that would indicate international influences on Canadian investment. A terms of trade variable (ratio of prices of goods exports to goods imports) and a ratio of 'world activity' to Canadian real domestic

product were used for this purpose. Both were tested linearly and, after dividing each series by its mean, multiplicatively with K^*. In the linear form neither variable was significant, while multiplicatively the terms of trade variable badly weakened the accelerator. The activity ratio had little effect. In addition, the long rate differential between Canada and the U.S. was included linearly. Unfortunately the rates themselves are highly collinear (.97 simple correlation), and even in index form the U.S. and Canadian government long-term bond interest index variables have a simple correlation of .896. If both interest rate indices are put in the NRC equation, neither is significant, and the U.S. index has a negative sign. If the U.S. index is put in without the Canadian variable, it has a coefficient of 280 with a t value of 11.7. The Canadian rate thus appears to be a slightly more important variable than the U.S. rate, but the strong collinearity between them does not allow us to say with any certainty what would be the effect of a change in the Canadian rate with the U.S. rate unchanged. Unilateral changes have happened to such a small extent in the past that econometric analysis cannot tell us what would be the result if it did happen. We are only able to say that our estimate of the effects on investment of a change in the Canadian rate are conditional upon the maintenance of the 'usual' interest rate differential between Canada and the U.S.

E. Putting the Phase Two Equations to Work

The experimentation thus far has simply involved the use of an OLS format to choose the optimum equation structure. We have attempted with some limited success to develop a theoretically justifiable structure that would perform adequately when fitted to our data period. For non-residential construction we now have an accelerator model embodying both expectations and cost-of-capital variables. Fitting the model produces the equation:

1Q53 - 4Q65 (OLS)

$$I^n_{NRC} = \underset{(2.15)}{-.90}\, TQ_1 + \underset{(4.96)}{2.02}\, TQ_2 + \underset{(12.06)}{4.86}\, TQ_3 + \underset{(7.83)}{3.09}\, TQ_4$$

$$+ \underset{(13.70)}{.0307} (KGAP)_t + \underset{(14.94)}{290.13} \sum_{i=0}^{10} W_i (10BI)_{t-i}$$

SEE = 36.4 $\bar{R}^2$ = .935 D/W = 1.31

I^n_{NRC} is quarterly net investment in non-residential construction in 1957 dollars, calculated by subtracting from gross investment 1% of the capital stock at the end of the last quarter. T is a trend term, running from 1 in 1Q47 to 76 in 4Q65, and the Q_i are seasonal dummies. KGAP is equal to $\sum_{i=0}^{10} W_i(K^*_{t-i} - K_{t-i-1})$, with W_i the same weighting pattern as used with 10BI. This is the pattern labelled PLLAG with $W_0 = W_1 = 0$, $W_2 = .06$, $W_3 = .11$, $W_4 = .16$, $W_5 = .17$, $W_6 = .16$, $W_7 = .13$, $W_8 = .11$, $W_9 = .07$, $W_{10} = .04$, and with all other $W_i = 0$. The K_t are values for quarterly net capital stock, construction-type, derived with an assumed 1% quarterly depreciation rate. K^*_t is the desired level of capacity, equal to $(Y_t) * (K/Y)^T_t * (CFR)_t$. The component variables are as follows: Real Domestic Product less Agriculture in constant 1957 dollars (Y_t); the trended capital/output ratio $(K/Y)^T_t$, which is the 'desired' ratio assumed to embody the various price, tax, discount rate, and other factors affecting the user cost of capital whose influence could not be measured directly; and $(CFR)_t$, which is the ratio of cash flow to its trend value, indicating both expectations about future sales and availability of internal finance. On the basis of experiments described above, we believe the expectations role to be dominant.

10BI is the ten-year bond index, calculated by dividing the current value of the yield on government bonds of ten years and over to maturity into the average value of this yield over the past twelve quarters. It is intended to represent the marginal cost of external debt finance, although it is recognized that it measures the average relative cost of debt finance rather than the marginal absolute cost. An experimentation with the index form was clearly superior to the rate form, which was wrongly signed. The ten-year government rate was used because it is endogenous to the overall simultaneous model; but it is theoretically preferable to use the industrial bond rate, which is the relevant

cost to private borrowers. Using this in index form yields:

1Q53 - 4Q65 (OLS)

$$I^{n}_{NRC} = \underset{(2.80)}{-1.21}\ TQ_1 + \underset{(4.04)}{1.71}\ TQ_2 + \underset{(10.89)}{4.55}\ TQ_3 + \underset{(6.81)}{2.78}\ TQ_4$$

$$+ \underset{(14.58)}{.0322}\ (KGAP)_t + \underset{(15.06)}{303.61} \sum_{i=0}^{10} W_i (IBI)_{t-i}$$

SEE = 36.2 $\bar{R}^2$ = .936 D/W = 1.33

As one would expect, this equation is slightly better on all counts, but as one would hope, it is very little different. Thus the use of the 10BI variable made necessary by the simultaneous model is an adequate approximation.

The Durbin/Watson statistic, however, suggests strongly that the residuals from both these equations are autocorrelated. Consequently, though the coefficients are unbiased, their standard errors are underestimated. To see how serious this problem was, we performed a first-order autoregressive transformation on all our variables using a value of $\rho = .35$, derived from the Durbin/Watson statistic, and then refitted the equation. This produced:

1Q53 - 4Q65 (AUTO, ρ = .35)

$$I^{n}_{NRC} = \underset{(1.64)}{-0.91}\ TQ_1 + \underset{(3.66)}{2.01}\ TQ_2 + \underset{(8.91)}{4.84}\ TQ_3 + \underset{(5.75)}{3.06}\ TQ_4$$

$$+ \underset{(9.85)}{.0307}\ (KGAP)_t + \underset{(10.40)}{291.43} \sum_{i=0}^{10} W_i (10BI)_{t-i}$$

SEE = 34.1 $\bar{R}^2$ = .935 D/W = 1.71

All standard errors have risen slightly, but in no case is the rise sufficient to cast serious doubts on the significance of a variable. The coefficients on the independent variables are effectively unchanged. The new Durbin/Watson statistic suggests that some second-order autocorrelation may be present, but the

problem does not seem severe enough to warrant attention.

The machinery and equipment investment equation is inferior to the NRC both in structure and in terms of goodness of fit. The CFR variable as an expectation indicator turns out to be unusable as a component of K^*, because the accelerator drops out of the equation when CFR is used multiplicatively with Y_t and $(K/Y)_t^T$. CFR does however enter very strongly in a linear current form, and knocks out all other financial variables. Efforts made to include other cost-of-capital variables, as described above, led to insignificant coefficients and/or wrong signs. Nor was there any observable trend in the seasonals, although it did appear that the strength of the accelerator varied over the year. Consequently the final equation form from the second stage experiments is:

1Q53 - 4Q65 (OLS)

$$I^n_{ME} = \underset{(4.65)}{-283.51}\, Q_1 - \underset{(2.83)}{221.31}\, Q_2 - \underset{(4.68)}{358.44}\, Q_3 - \underset{(4.58)}{319.08}\, Q_4$$

$$+ \underset{(4.78)}{.142}\, Q_1\ \text{KGAP} + \underset{(4.62)}{.136}\, Q_2\ \text{KGAP} + \underset{(4.47)}{.124}\, Q_3\ \text{KGAP}$$

$$+ \underset{(6.38)}{.174}\, Q_4\ \text{KGAP} + \underset{(5.52)}{385.0}\, \text{CFR}_t$$

SEE = 44.0 $\bar{R}^2 = .840$ D/W = 0.73

In this equation I^n_{ME} is net investment in machinery and equipment, found by subtracting 5% of end-of-last-quarter stock from this quarter's gross investment. $(KGAP)_t$ is defined as above except that: (a), K now refers to the stock of machinery rather than of buildings; (b), CFR is not included in K^*, and (c), the weighting pattern of W_i is now MLAG with $W_0 = 0$, $W_1 = .10$, $W_2 = .15$, $W_3 = .30$, $W_4 = .25$, $W_5 = .15$, $W_6 = .05$, and with all other $W_i = 0$. In this form also CFR appears to play an expectational role; although its behaviour in the presence of stock market variables suggested a possible internal funds constraint as well. It is interesting that the behaviour of CFR differs in the

two equations — the current form being superior for M&E while the lag is best for NRC.

In this equation, autocorrelation is an even more severe problem than in NRC, which probably reflects the less adequate specification. It was also refitted after a first-order autoregressive transformation which used $\rho = .65$, as indicated by the Durbin/Watson statistic in the OLS equation. The results from this were:

1Q53 - 4Q65 (AUTO, $\rho = .65$)

$$I^n_{ME} = \underset{(2.98)}{-218.59}\, Q_1 - \underset{(1.51)}{141.02}\, Q_2 - \underset{(3.07)}{281.25}\, Q_3 - \underset{(3.00)}{249.22}\, Q_4$$

$$+ \underset{(5.86)}{.176}\, Q_1\, KGAP + \underset{(5.19)}{.159}\, Q_2\, KGAP + \underset{(4.52)}{.133}\, Q_3\, KGAP$$

$$+ \underset{(6.24)}{.181}\, Q_4\, KGAP + \underset{(3.79)}{314.88}\, CFR_t$$

SEE = 33.5 $\bar{R}^2 = .892$ D/W = 1.78

The seasonal pattern is somewhat changed, and the average accelerator coefficient has risen from .144 to .162. The significance of the accelerator, however, is unchanged, and only the CFR falls slightly. The equation fit is improved, and the standard error of estimate falls sharply. Again, some second-order autocorrelation may be present but is no cause for concern.

The values of I^n derived from the AUTO equations are then added to ρK_{t-1} to derive gross investment series for NRC and M&E. In Chart 2 the actual series are graphed against estimated values from equations fitted 1953-1965. In addition the equations were run forwards into 1966 and 1967 and compared with actual values of those years.

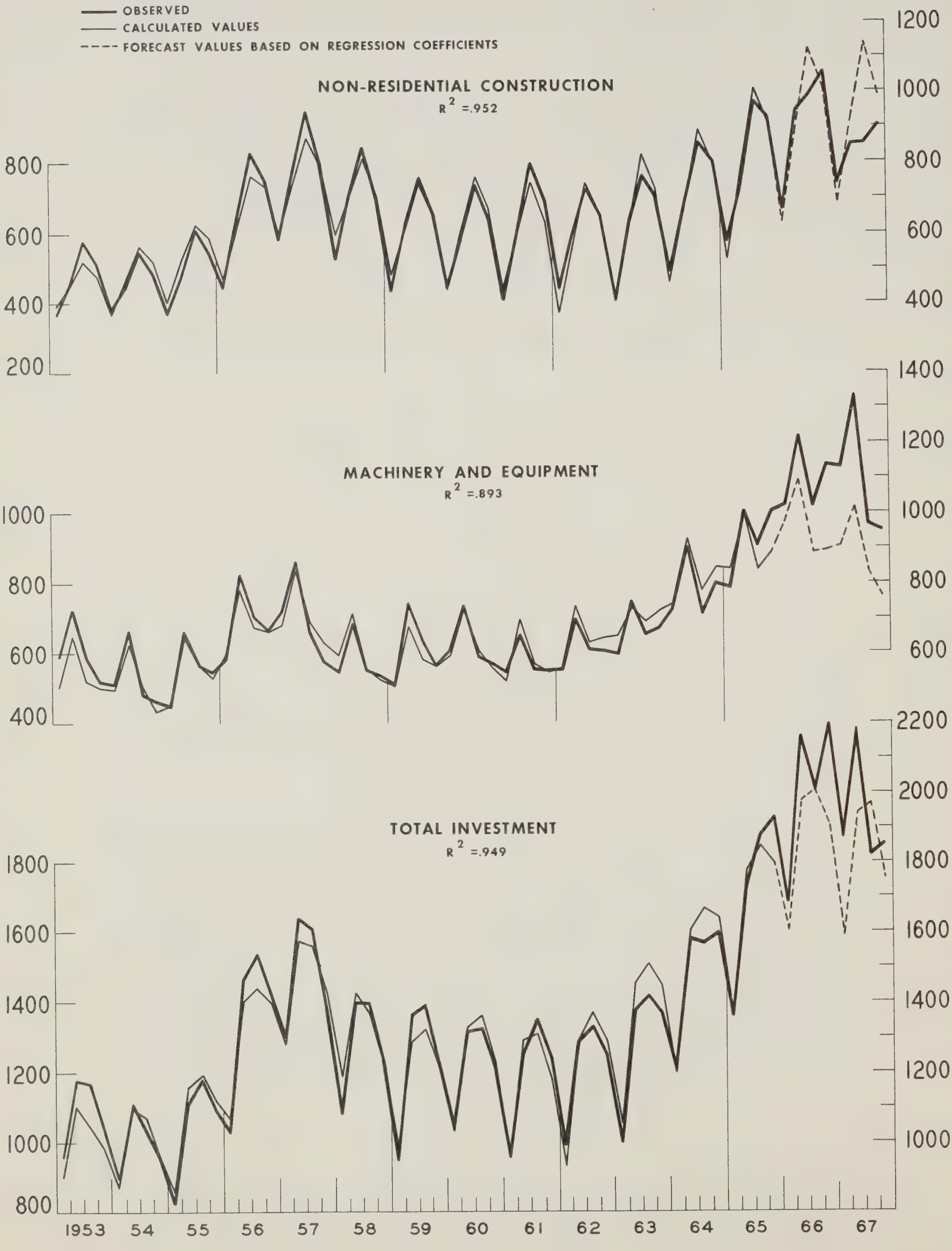
The OLS and AUTO equations are not significantly affected by simultaneity problems, since only the current CFR in the M&E equation is simultaneously determined with investment. All other

Chart 2

GROSS FIXED INVESTMENT FROM EQUATIONS FITTED 1953-65 AND USED TO FORECAST 1966-67

Quarterly - Millions of 1957 Dollars

R^2 measures the fit of the calculated gross investment series over the 1953-65 estimation period.



variables are either exogenous or predetermined. Since the errors in the M&E equations are fairly strongly autocorrelated (ρ = .65), the forecast values from the equation are considerably influenced by the choice of the forecast horizon. The forecasts shown in Chart 2 are started in 1Q66. Although they include knowledge of the forecasting error in 4Q65, they assume that forecasts are not revised on the basis of subsequent forecasting experience. This aspect of the choice of a starting date for a forecasting test affects only the M&E equation, as there is little autocorrelation of the NRC residuals; in any case the NRC equation fits better.

Note that the M&E equation fails to catch adequately the strong burst of spending in 1966 and early 1967. The NRC equation generally fits well, but misses the surprising weakness in construction in 3Q67. Could that many people have finished their Centennial projects by midyear? The forecast for total investment, being the sum of the forecasts for M&E and NRC, also fits fairly well, but has a mean absolute error of 8% of gross investment.

In order to obtain a longer forecasting period and an estimation period comparable to that used by Wilson [28] in his careful analysis of total quarterly capital expenditures, we reestimated the equations using 1953-63 data and used them for some additional forecasting tests.

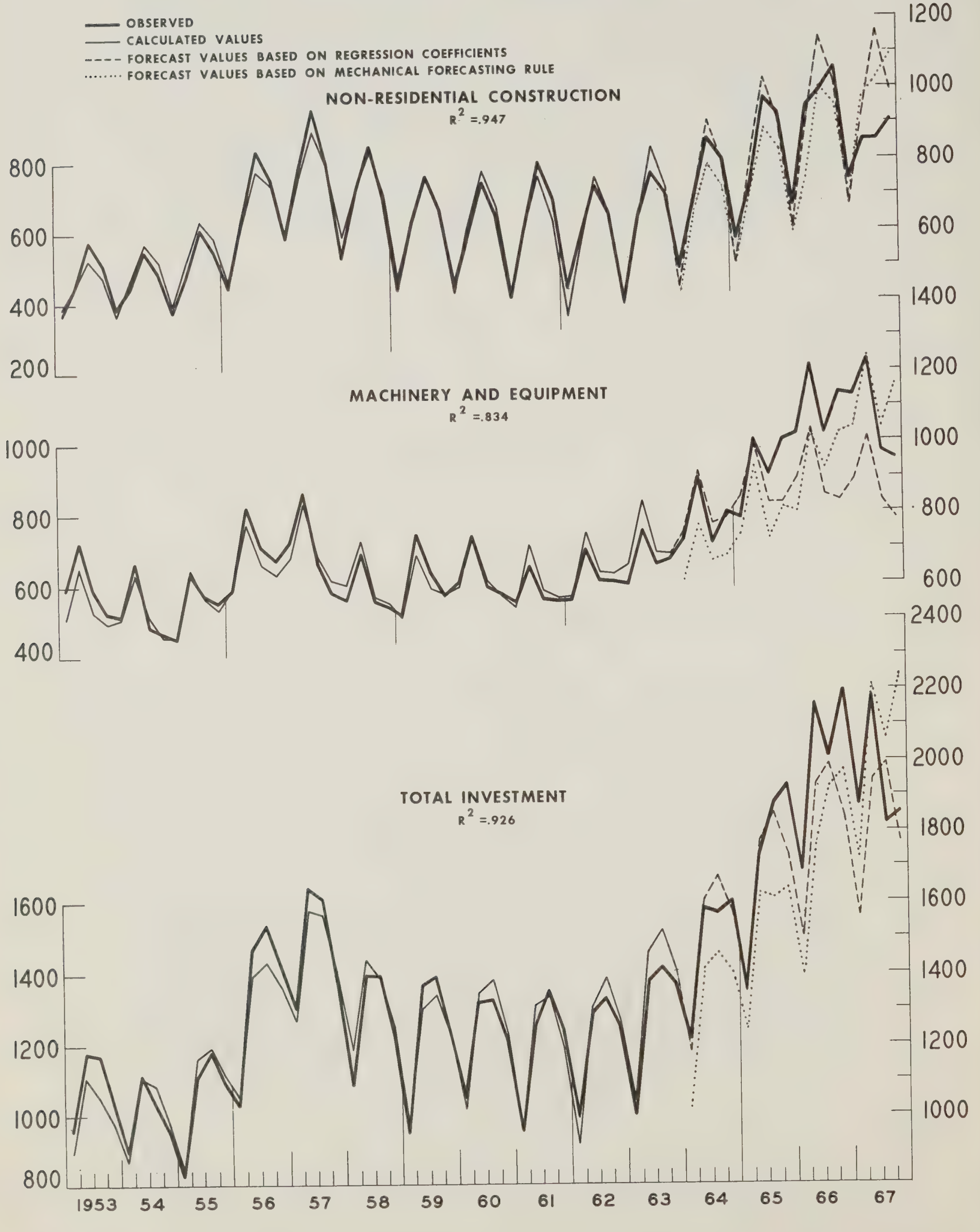
Chart 3 shows the calculated and forecast values based on the shorter estimation period. Over the 1953-63 period, our equation for total investment (obtained by summing the equations for NRC and M&E) has an R^2 of .926 and a standard error of estimate of $53.5 million. This is quite comparable with the seasonally unadjusted data version of Wilson's preferred equation ([28] Table 5, equation 3) which has an R^2 of .923 and a standard error of estimate of $52.6 million. With respect to forecasting ability, it is not possible to compare the two models on a quarterly basis, as Wilson conducts all his forecasting experiments using an equation fitted to seasonally adjusted data. As an alternative forecasting test, we set up what seemed to us the most appropriate mechanical forecasting rule. Under this rule, the forecast for any quarter is equal to the actual expenditures in the same quarter of the previous year, multiplied by the

Chart 3

GROSS FIXED INVESTMENT FROM EQUATIONS FITTED 1953-63 AND USED TO FORECAST 1964-67

Quarterly - Millions of 1957 Dollars

R^2 measures the fit of the calculated gross capital expenditures series over the 1953-63 estimation period.



(arithmetic) average (1953-63) of actual expenditures divided by expenditures in the corresponding quarter of the previous year. We applied the rule separately for NRC and M&E, and obtained an estimate of the total by summing. We obtained forecasts from our model by starting in 4Q63, and by using the actual 1964-67 values of the predetermined variables.[11] The results of both sets of forecasts are shown in Chart 3. In forecasting total gross business capital expenditures, the average absolute forecasting error from our equations for the sixteen quarter forecast period, 1Q63 - 4Q67, is $130 million, while the corresponding error for the mechanical rule is $205 million. This marked superiority of the equations over the forecasting rule is substantially reduced if one looks only at the forecasts for NRC and M&E separately. Much of the assistance provided by the equations at the aggregate level is due to a general absence of errors of the same sign for NRC and M&E. For the NRC forecasts taken by themselves, the equation forecasts gross investment with an average absolute error of $72 million compared to an average absolute error of $90 million for the mechanical rule. For M&E the mechanical rule forecasts slightly better than our equation, with an average absolute error of $127 million compared to $133 million for our equation. In the aggregate, however, the mechanical rule loses out due to its propensity to be wrong on both M&E and NRC in the same direction at the same time.

If the equations are used in a way that takes account of the autocorrelation of the forecasting errors, their performance is further improved relative to the mechanical rule. The mechanical rule already takes account of the autocorrelation of errors by being based on the actual investment in the same quarter of the preceding year. If the M&E and NRC equations are restarted every quarter, taking account of the error in the previous quarter, the average absolute error of our M&E forecast drops from $130 million

[11]The test is not on all fours, as the mechanical model is favoured by being based on actual values of investment drawn from within the forecast period, while our model uses (lagged values of) endogenous variables generated during the forecast period. Given the autoregressive structure of M&E forecasting errors, the test probably favours the mechanical model. Note that the forecast and the mechanical model both run behind from 3Q65 to 1Q66, but the mechanical model then 'learns' from its errors and catches up — Chart 3. Our model, like a real-life forecaster in 1963, cannot do this.

to \$72 million. The average absolute error of the NRC forecast rises by \$1 million while the average absolute error of the aggregate forecast drops by 20 per cent, from \$128 million to \$105 million. Unfortunately, forecasting performance achieved in this way is of little cheer to the man who has to forecast two or three years into the future.

Looking over our brief range of tests of the phase two equations, we concluded that they provide some support for our earlier judgment that the NRC equation is fairly sound, while suggesting that further work on the M&E equation might permit better specification of the structure underlying M&E expenditures. The next and final section of the paper reports on our further experiments and presents the latest pair of equations.

F. Further Tests and the Final Equations

In our phase one and two experiments we defined the desired capital output ratio by a trend-through-peaks method, where the dating of the peaks was determined by the relation between capacity and output for the capital stock as a whole. In our latest experiments we have permitted M&E and NRC to have their trends-through-peaks determined separately. The peaks are unchanged for NRC, but for M&E there are now three peaks: 3Q56 and 4Q65, as before, and also 4Q63. The new K/Y equation is:

$$(K/Y)_{ME} = 1.8217 - .00676\ T_1 - .000646\ T_2$$

where T_1 is a time trend starting with the value 1 in 1Q50 and ending in 4Q63, and T_2 is a time trend starting with the value of 1 in 1Q64.

After defining a new K/Y equation for M&E, we had to go back to our phase two experiments and search again for convergence between the assumed rate of depreciation ρ and c — the estimated rate of replacement investment. This also gave us a chance to test the significance of our earlier misgivings about the assumption that ρ should equal c. If the rate of 'automatic' replacement c is chosen by investors so as to maintain the physical productivity of their capital stock (there is no very obvious reason why the rate should be so chosen), then ρ will be greater

than c if there is a positive rate of embodied technical progress. Since the data on the prices of secondhand capital goods are presently not adequate to permit estimation of the rate of embodied technical progress,[12] we tested the consequences of various discrepancies between ρ and c in terms of the structure and predictive power of our investment equations.

Table 12 shows that in the second phase gross investment

Table 12 Results of Gross M&E Regressions*

Assumed rate of depreciation	Estimated coefficient on K_{t-1}			
ρ	c	ρ - c	$\bar{R}^2$	SEE
.040	.04489	-.00489	.8411	50.76
⋮				
.045	.04851	-.00351	.8489	49.49
.046	.04900	-.00300	.8501	49.28
.047	.04941	-.00241	.8513	49.10
.048	.04973	-.00173	.8522	48.94
.049	.04996	-.00096	.8531	48.80
.050	.05007	-.00007	.8538	48.69
.051	.05010	.00090	.8543	48.60
.052	.05004	.00196	.8547	48.54
.053	.04989	.00311	.8549	48.50
.054	.04965	.00435	.8549	48.50
.055	.04933	.00567	.8547	48.53
⋮				
.060	.04704	.01296	.8507	49.19

* The equation form estimated was:

$$I^g_{ME} = a_1Q_1 + a_2Q_2 + a_3Q_3 + a_4Q_4 + b_1Q_1\ \text{KGAP} + b_2Q_2\ \text{KGAP}$$

$$+ b_3Q_3\ \text{KGAP} + b_4Q_4\ \text{KGAP} + cK_{t-1}$$

[12]The problems of identifying the rate are considered in some detail by Hall [10].

model, using the new K/Y equation for M&E, convergence between ρ and c was once again obtained with a ρ of .05 per quarter. Positive rates of embodied technical progress appear to require an assumed rate of depreciation greater than .050. Although the differences are tiny, the value of $\bar{R}^2$ reaches a maximum at $\rho = .053$ and .054, suggesting a .003 or .004 quarterly rate of embodied technical progress. The model with $\rho = .053$, $c = .050$ was then converted into a net investment equation; the current CFR variable was added, parameters estimated with and without autoregressive transformation, and the final results compared to those from the model with $\rho = c = .05$. The standard error of estimate, $\bar{R}^2$, and the forecasting properties of the model with $\rho = c$ were marginally better than those of the models with $\rho > c$.[13] Thus we decided to continue using a model with $\rho = c$. The new K/Y relationship produced a considerable increase in the goodness of fit of the net M&E equation and a less marked, but still worthwhile, increase in forecasting ability.

As a final set of experiments, we tried adjusting all our interest rate variables to allow for changes in expected rates of change of prices. Our 'real' 10BY, for example, was defined as $10BY - 100\left[\frac{PGNE - PGNE_{t-4}}{PGNE_{t-4}}\right]$, where PGNE is the implicit private gross national expenditures price deflator generated in RDX1. These real interest rate variables worsened the fit of our equations, whether in level or index form. Perhaps alternative assumptions about the formation of price expectations would allow price-adjusted interest rates to play a role in our model, but for the time being raw rates will have to do.

We proceed now to outline our final equations, as used in

[13]This would be a puzzling result if CFR really were uncorrelated with the KGAP variables. However, CFR in the 1953-65 sample period has simple correlations with the KGAP variables of .30, -.01, -.01, and .13. This shifts the peak $\bar{R}^2$, if CFR is included in the gross investment model, to a point where $\rho = .043$ and $\rho - c = -.0075$. On a priori grounds we resisted the assumptions about the rate of embodied technical progress and/or replacement behaviour required to justify values of c greater than ρ. In any event, there was next to nothing to be gained, either in goodness of fit or forecasting ability, by altering our earlier procedure of running the gross investment equations without financial variables.

the RDX1 aggregate model. Our coefficients differ slightly from those in the aggregate model because in RDX1 PGNE has to be used as a proxy for the investment goods price index used in calculating CFR.

The OLS estimation of our final M&E equation produced the following:

1Q53 - 4Q65 (OLS)

$$I^n_{ME} = \underset{(3.82)}{-209.54}\ Q_1 - \underset{(1.83)}{128.40}\ Q_2 - \underset{(3.96)}{270.64}\ Q_3 - \underset{(3.71)}{231.31}\ Q_4$$

$$+ \underset{(5.76)}{.170}\ Q_1\ KGAP + \underset{(6.03)}{.176}\ Q_2\ KGAP + \underset{(5.36)}{.148}\ Q_3\ KGAP$$

$$+ \underset{(7.58)}{.201}\ Q_4\ KGAP + \underset{(5.08)}{315.41}\ CFR_t$$

SEE = 38.5 $\bar{R}^2$ = .878 D/W = 0.88

The equation marks an improvement in several respects. The standard error of estimate is down by about 10%, the accelerator coefficients are increased in size and significance, and the autocorrelation of residuals is reduced. Reestimation after autoregressive transformation (ρ = .56) produced slight further improvement and the final equation:

1Q53 - 4Q65 (AUTO, ρ = .56)

$$I^n_{ME} = \underset{(2.84)}{-192.68}\ Q_1 - \underset{(1.30)}{112.49}\ Q_2 - \underset{(3.06)}{257.33}\ Q_3 - \underset{(2.87)}{220.1}\ Q_4$$

$$+ \underset{(6.56)}{.195}\ Q_1\ KGAP + \underset{(6.29)}{.189}\ Q_2\ KGAP + \underset{(5.29)}{.151}\ Q_3\ KGAP$$

$$+ \underset{(7.23)}{.201}\ Q_4\ KGAP + \underset{(3.98)}{304.54}\ CFR_t$$

$$SEE = 32.4 \qquad \bar{R}^2 = .895 \qquad D/W = 1.70$$

In the aggregate model RDX1, this equation will be used in conjunction with the final NRC equation outlined in the last section:

1Q53 - 4Q65 (AUTO, ρ = .35)

$$I^n_{NRC} = \underset{(1.64)}{-.091}\, TQ_1 + \underset{(3.66)}{2.01}\, TQ_2 + \underset{(8.91)}{4.84}\, TQ_3 + \underset{(5.75)}{3.06}\, TQ_4$$

$$+ \underset{(9.85)}{.0307}\, KGAP_t + \underset{(10.40)}{291.43} \sum_{i=0}^{10} W_i (10BI)_{t-i}$$

$$SEE = 34.1 \qquad \bar{R}^2 = .935 \qquad D/W = 1.71$$

In the last section we presented the results of some quarterly forecasting tests using gross investment series derived from the final NRC equation and the best phase two M&E equation. Chart 4 repeats the NRC graph from Chart 2 and adds the M&E and Total Gross Investment series derived from our final equations. Note that the values of R^2 (which are measured over the estimation period only) are increased both for gross M&E and total investment. This is true whether the equations are fitted to the end of 1963 or the end of 1965. The increases in forecasting accuracy are not so marked. For the equations fitted to the end of 1963 and used to forecast 1964-67, the average absolute error of the quarterly M&E forecast drops from \$133 million to \$120 million, enough to beat the mechanical forecasting rule but still not an outstanding record. The average quarterly absolute error of forecast for total gross investment drops from \$130 million to \$127 million, showing that some of the improvement in the M&E equation is washed out in the aggregate.

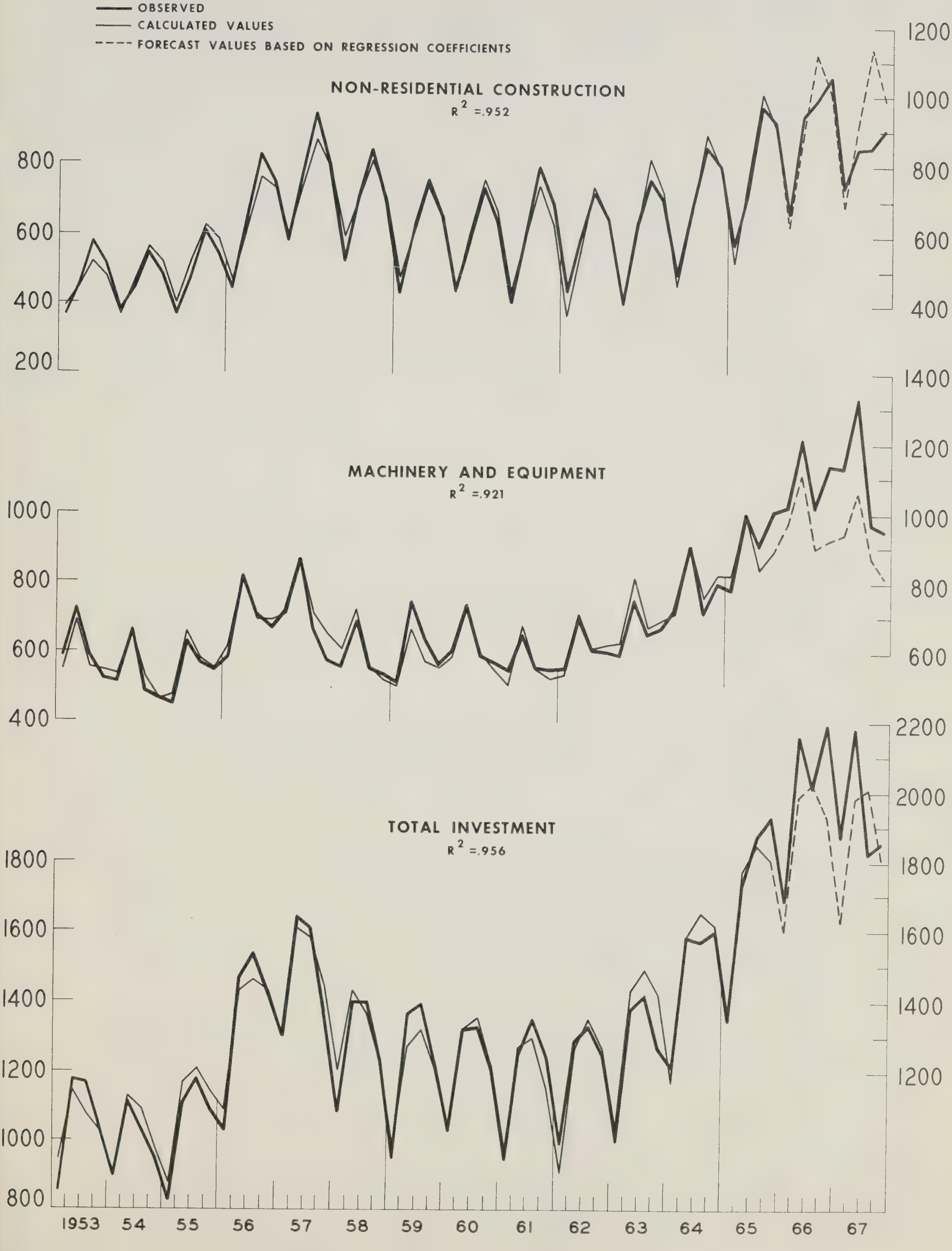
To allow our equations to be compared to other forecasting methods, we initialized the model in 4Q63 and used it to generate four annual investment forecasts. The percentage errors of these forecasts are shown below, along with the comparable forecasts from T. Wilson's model ([28] p. 73) and from the annual survey of

Chart 4

GROSS FIXED INVESTMENT FROM FINAL EQUATIONS FITTED 1953-65 AND USED TO FORECAST 1966-67

Quarterly - Millions of 1957 Dollars

R^2 measures the fit of the calculated gross investment series over the 1953-65 estimation period.



investment intentions.[14] The forecasting errors are shown as a percentage of actual gross expenditures for the same year. The percentage error is shown as positive if actual investment exceeded the forecast.

	Annual Investment Survey			Wilson[15]	Our Equations		
	M&E	NRC	Total	Total	M&E	NRC	Total
Year	%	%	%	%	%	%	%
1964	13.9	8.5	11.3	3.3	1.6	0.3	1.0
1965	10.6	5.4	8.1	6.6	7.6	- 1.0	3.6
1966	7.3	5.5	6.4	11.6	17.0	0.0	9.3
1967[16]	0.3	-1.8	-0.6	n.a.	17.0	-12.1	4.4
Average percentage error	8.0	5.3	6.6	7.2	10.8	3.3	4.6

Our equations provide somewhat better forecasts for total investment and NRC, but are inferior to the investment survey for M&E. Since the investment survey and our equations are based on

[14]The forecast and actual expenditures are reported in [3] Canada, Department of Trade and Commerce, *Public and Private Investment in Canada*. The comparison between the investment survey and the equations must be in percentage terms since the survey is in terms of current dollars and the equation in terms of constant 1957$.

[15]Wilson's equation forecasts better if a subsequent quarter is chosen for starting although that leaves only 1965 and 1966 available for comparison. If his 1965 and 1966 forecasts are obtained from each of the four alternative starting quarters, and the results averaged, his equation has a forecast error of 3.9% in 1965 and 9.3% in 1966, both quite comparable to the results from our equations. Our equations are much less sensitive to the choice of starting period, since our coefficients of autocorrelation of residuals are .35 and .56 for NRC and M&E, compared to Wilson's .75.

[16]Since the 1967 Actual investment survey figures were not published when this was written, the Preliminary Actual figures were used in assessing the investment survey forecasts for 1967.

quite different information, and make forecasting errors at different times, there may be some scope for improving the accuracy of short-term forecasting by combining the forecasts obtained from the two sources. For longer term forecasts, only the equations are available, since the investment survey results are only available at the start of the forecast year.

For policy simulations, we must rely on the equations, and, for most purposes, must imbed them in a complete model of the economy. We hope that our present equations will simulate investment behaviour adequately within the aggregate RDX1 model, while the results of extensive simulations with the aggregate model will no doubt suggest ways in which our investment equations may be improved.

APPENDIX A

Fiscal Policy Variables

The fiscal policy variables that we are trying to insert into our investment equations are of two forms. The first, CPV, is an attempt to measure current conditions, and enters into the determination of desired capital stock in the flexible accelerator/ stock adjustment model. The second, FPV/CPV, is the ratio of future to present conditions, and is assumed to influence the rate of adjustment of capital stock. Thus, if policy conditions eighteen months hence are expected to be tighter than at present, one would expect a deficiency in actual, as compared with desired, capital stock to be made up more rapidly.

CPV attempts to capture the influence of accelerated and deferred depreciation schemes; and of changes in sales tax provisions, while FPV is investors' current expectations as to the value of CPV eighteen months hence, on the naive assumption that they believe what the government tells them. The present value of a policy measure is calculated as a percentage of the cost of investment under that measure, and this, adjusted for the proportion of total investment subject to the measure, yields the impact of the provision. Although taxes do not come in directly, their influence is felt early in the period since a lower tax rate lowers the present value of any depreciation scheme. Using 1Q51 as a base period the policy variables are calculated for each quarter from 1947 to 1965. The present value of depreciation provisions can be found by the calculation:

$$P.V. = I \times T \times \frac{d}{d+R}$$

where I is the level of investment, T is the corporate tax rate, d is the rate of depreciation allowed with a declining balance system, and R is the discount rate assumed to be used by investors. Assuming $R = 10\%$, $T = 50\%$, we know that for non-residential construction $d = .05$, and for machinery and equipment $d = .2$. Thus in 1Q51, P.V. for NRC is .1667I, and P.V. for M&E is .3333I. Since 1Q51 is our base period, our policy variables are set equal

to 100 for these values.

Working backward, the tax rate in 4Q50 was only 43%, and the P.V. of the depreciation provisions fall to .1433I and .2866I respectively. We had the choice here of allowing our index to rise or to fall — we decided to let it move analogously to an index of capital goods prices and to rise as depreciation policy becomes less of an incentive to investment. So our current indices rise to 102.3% and 104.7%, moving by a percentage equal to the change in per cent of investment returned through the depreciation provisions.

From 1Q49 to 4Q50 the corporate tax rate was 40%, and our indices are 103.3% for NRC and 106.7% for M&E. In 1947 and 1948 the P.V. of depreciation must be calculated on a different basis, since straight-line depreciation, at rates of $2\frac{1}{2}$% and 10% with a 37% tax rate, was in force. These provisions had a P.V. of .0905I and .2363I respectively, yielding indices of 107.6 and 109.7 for the period 1Q47 to 4Q48.

Moving forward again, in 2Q51 the deferred depreciation scheme was introduced. This deferred allowable depreciation for four years and reduced the value of NRC depreciation to .11381 and of M&E depreciation to .22771. Our index rises to 105.3 and 110.6, and remains up until 4Q52, when the deferment was discontinued. Both current indices fall back to 100 and remain there until 4Q60.

In 1Q61 Regulation 1108 went into effect. This provided for depreciation of 10% in the first year and 5% in succeeding years on NRC and of 40% and 20% on M&E. Regulation 1108 applied only to investment for the production of goods of a kind new to Canada, or to investment new to a surplus manpower area. In fact, however, the influence of these provisions was quite small, and, when account is taken of the minute proportion of total investment eligible for this acceleration, the effect on our index is nil. This provision was in force from 1Q61 to 4Q63 but appears to have had little or no effect on the profitability of investment.

In 3Q61 Regulation 1109 provided for first year depreciation of $7\frac{1}{2}$% and 30% on investment for reequipment and modernization. This provision had more influence on investment since it applied to all investment, even though the stimulus given to projects

undertaken under the regulation was less than for Regulation 1108. Regulation 1109 shifts our indices down to 99.3 for NRC and 98.5 for M&E from 3Q61 to 2Q63. It remained in force through 1Q64, but after 2Q63 its effects are offset by other provisions.

In the third quarter of 1963 an accelerated provision was brought in which allowed 20% straight-line depreciation for NRC and 50% straight-line for M&E. This raised the value of depreciation provision to .3791I and .4339I respectively. But the provision was restricted to investment in manufacturing and processing in surplus manpower areas. Firms meeting certain Canadian ownership requirements could also claim accelerated depreciation for machinery and equipment investment outside surplus manpower areas. This provision was to last from 3Q63 to 2Q65. In 1964 it was extended to 1Q67, a feature that influences the future index, not the current one. The value of depreciation for investment made under the provision increased by 21.3% for NRC and 10.1% for M&E. When allowance is made for its limited coverage, however, it moves our indices by 0.3% and 2.4%.

During the same budget, the sales tax was applied to hitherto exempt building materials and production machinery, in stages of 4% (3Q63 to 1Q64), 8% (2Q64 to 4Q64), and 11% thereafter. This raises our index by 4%, 8%, and 11% for M&E for these periods. Consultation with D.B.S. indicated that for NRC about 42% of investment consisted of taxable materials; therefore the rate of sales tax was reduced by this percentage to yield the change in index.

Thus from 3Q63 to 1Q64, Regulation 1109 is tending to reduce our indices by 0.7% and 1.5%, the depressed area and other production machinery provisions to reduce them by 0.3% and 2.4%, but the sales tax works to increase them by 1.7% and 4%. The net effect is to raise the indices to 100.7 and 100.1. During the first two of these three quarters, Regulation 1108 was reaching the end of its ineffectual life. In 2Q64, Regulation 1109 ran out, and from then till 4Q64 the sales tax was at 8%. Our indices stand at 103.1 and 105.6. From 1Q65 to 1Q66 the sales tax was up to 11%, and the depressed area and other provisions were still in force. The indices are 104.3 and 108.6. In 2Q66, the new depreciation deferment raises these to 108.4 and 116.9; and there the matter rests.

For the index of expected future conditions, we employ the naive assumption that investors believe everything the government tells them. Thus from 1Q47 to 1Q52 the future indices are equal to the current. This is because, when the 1951 deferment was initially announced, it was to be in force for several years. By 2Q52, however, government statements made it clear that the deferment would terminate by the end of the year. In that quarter our indices return to 100.

The future indices do not move again until 3Q61 when Regulation 1109 pushes them down to 99.3 and 98.5. But since this regulation was to expire on April 1, 1964, its influence disappears from the future series in 4Q62. In 3Q63 the sales tax exemptions were withdrawn, and the depressed area provision was introduced. Both were expected to be in force eighteen months hence; the sales tax being at its full 11% rate. Thus for 3Q63 and 4Q63 the net effects on the indices are sales tax, up 4.6% and 11%, depressed area provisions, down 0.3% and 2.4%. So the future indices are 104.3 and 108.6. In 1Q64 the depreciation acceleration was expected to run out in 3Q65; hence the indices go up to 104.6 and 111.0. But on March 16, 1964 the depressed area provisions were extended to April 1, 1967; therefore the NRC future index falls to 104.3 until 4Q65. Henceforth it returns to 104.6.

For machinery and equipment the picture is a little more complicated. Of the movement in the index due to the 1963 depreciation provisions, about 0.3% is attributed to the depressed area aspect. So the index from 2Q64 to 2Q65 stands at 110.7. On April 26, 1965 the whole machinery and equipment acceleration was extended until December 1966; therefore in 2Q65 the index stands at 108.6. In 3Q65 it returns to 110.7, and in 4Q65 and 1Q66 (looking ahead to 2Q67 and 3Q67) it returns to 111.0. In 2Q66, looking ahead to 4Q67, the new deferment provisions will no longer be in force and the sales tax on production machinery will be down to 6%. The index thus stands at 106.0.

Tables 13 and 16 on the following four pages give the calculated values of the policy index from 1947 to mid-1966. The resulting index could undoubtedly be improved, particularly by a more sophisticated measure of expectations.

Table 13

CPV — Non-Residential Construction — Current

	1Q	2Q	3Q	4Q
1947	107.6	107.6	107.6	107.6
1948	107.6	107.6	107.6	107.6
1949	103.3	103.3	103.3	103.3
1950	103.3	103.3	103.3	102.3
1951	100.0	105.3	105.3	105.3
1952	105.3	105.3	105.3	105.3
1953	100.0	100.0	100.0	100.0
1954	100.0	100.0	100.0	100.0
1955	100.0	100.0	100.0	100.0
1956	100.0	100.0	100.0	100.0
1957	100.0	100.0	100.0	100.0
1958	100.0	100.0	100.0	100.0
1959	100.0	100.0	100.0	100.0
1960	100.0	100.0	100.0	100.0
1961	100.0	100.0	99.3	99.3
1962	99.3	99.3	99.3	99.3
1963	99.3	99.3	100.7	100.7
1964	100.7	103.1	103.1	103.1
1965	104.3	104.3	104.3	104.3
1966	104.3	108.4		

Table 14

CPV — Machinery and Equipment — Current

	1Q	2Q	3Q	4Q
1947	109.7	109.7	109.7	109.7
1948	109.7	109.7	109.7	109.7
1949	106.7	106.7	106.7	106.7
1950	106.7	106.7	106.7	104.7
1951	100.0	110.6	110.6	110.6
1952	110.6	110.6	110.6	110.6
1953	100.0	100.0	100.0	100.0
1954	100.0	100.0	100.0	100.0
1955	100.0	100.0	100.0	100.0
1956	100.0	100.0	100.0	100.0
1957	100.0	100.0	100.0	100.0
1958	100.0	100.0	100.0	100.0
1959	100.0	100.0	100.0	100.0
1960	100.0	100.0	100.0	100.0
1961	100.0	100.0	98.5	98.5
1962	98.5	98.5	98.5	98.5
1963	98.5	98.5	100.1	100.1
1964	100.1	105.6	105.6	105.6
1965	108.6	108.6	108.6	108.6
1966	108.6	116.9		

Table 15

FPV—Non-Residential Construction—18 Months Forward

	1Q	2Q	3Q	4Q
1947	107.6	107.6	107.6	107.6
1948	107.6	107.6	107.6	107.6
1949	103.3	103.3	103.3	103.3
1950	103.3	103.3	103.3	102.3
1951	100.0	105.3	105.3	105.3
1952	105.3	100.0	100.0	100.0
1953	100.0	100.0	100.0	100.0
1954	100.0	100.0	100.0	100.0
1955	100.0	100.0	100.0	100.0
1956	100.0	100.0	100.0	100.0
1957	100.0	100.0	100.0	100.0
1958	100.0	100.0	100.0	100.0
1959	100.0	100.0	100.0	100.0
1960	100.0	100.0	100.0	100.0
1961	100.0	100.0	99.3	99.3
1962	99.3	99.3	99.3	100.0
1963	100.0	100.0	104.3	104.3
1964	104.6	104.3	104.3	104.3
1965	104.3	104.3	104.3	104.3
1966	104.6	104.6		

Table 16

FPV—Machinery and Equipment—18 Months Forward

	1Q	2Q	3Q	4Q
1947	109.7	109.7	109.7	109.7
1948	109.7	109.7	109.7	109.7
1949	106.7	106.7	106.7	106.7
1950	106.7	106.7	106.7	105.7
1951	100.0	110.6	110.6	110.6
1952	110.6	100.0	100.0	100.0
1953	100.0	100.0	100.0	100.0
1954	100.0	100.0	100.0	100.0
1955	100.0	100.0	100.0	100.0
1956	100.0	100.0	100.0	100.0
1957	100.0	100.0	100.0	100.0
1958	100.0	100.0	100.0	100.0
1959	100.0	100.0	100.0	100.0
1960	100.0	100.0	100.0	100.0
1961	100.0	100.0	98.5	98.5
1962	98.5	98.5	98.5	100.0
1963	100.0	100.0	108.6	108.6
1964	111.0	110.7	110.7	110.7
1965	110.7	108.6	110.7	111.0
1966	111.0	111.0		

APPENDIX B

Key to the Variables

DB — Numbers in brackets with the prefix DB refer to the index numbers of these series on the Databank Master Tape at the Bank of Canada. It is intended to make publicly available a master tape containing all series referred to in the Bank of Canada Staff Research Studies.

Dependent Variables

I_{NRC} — (or I^g_{NRC}) Gross investment in non-residential construction, quarterly, constant 1957 dollars unadjusted, National Accounts basis, (DB 146).

$I_{M\&E}$ — (or $I^g_{M\&E}$) Gross investment in machinery and equipment, quarterly, constant 1957 dollars unadjusted, National Accounts basis, (DB 147).

I^n_{NRC} — Net investment in non-residential construction, equals I_{NRC} less assumed depreciation equal to a constant proportion of NRC capital stock at end of previous quarter. [constant = ρ]

$I^n_{M\&E}$ — Net investment in machinery and equipment, equals $I_{M\&E}$ less assumed depreciation equal to a constant proportion of M&E capital stock at end of previous quarter. [constant = ρ]

Independent Variables — First Stage

K_{t-1} — Net constant dollar capital stock at end of quarter t-1 found by cumulating net investment onto a mid-1949 base value. Separate series calculated for NRC and M&E using various assumed constant proportional depreciation rates.

$KGAP_t$ — The value in quarter t of a weighted average of capital shortages in past periods $t-i$, of the form

$$KGAP_t = \sum_{i=0}^{n} W_i \left(K^*_{t-i} - K_{t-i-1}\right) \text{ where } \sum_{i=0}^{n} W_i = 1.$$

It is calculated separately for NRC and M&E using various patterns of W_i, various K_t series, and different specifications of K^*_t.

K^*_t — The 'desired' level of NRC-type or M&E-type capital stock in period t. This variable is computed by multiplying the 'desired' capital/output ratio by the current level of output. The 'desired' capital/output ratio was calculated first as an average of past ratios, then as a trend-through-troughs using troughs of K/Y as approximations to full capacity output. Thus we have:

$$K^*_t = 1/12 \sum_{i=1}^{12} (K/Y)_{t-i} \, (Y_t) \text{ and } K^*_t = (K/Y)^T (Y_t)$$

Y_t — The level of output in constant 1957 dollars unadjusted, tested both as Gross National Expenditure and as Real Domestic Product less Agriculture. (DB 157, DB 2565) (The latter is in index form and was multiplied by a base value).

SLAG, MLAG, etc. — These are labels for the patterns of W_i tested and are specified in Table 2 on page 17 and illustrated in Chart 5 on page 77.

Independent Variables — Second Stage

F_t — Any financial variable in quarter t, no specific content.

CFR_t — The cash flow ratio in quarter t. Cash flow is the sum of corporate retained earnings, (DB 1393) and depreciation allowances, (DB 3711), deflated by the ratio of current to constant dollar business spending on plant

and equipment. This is fitted to a linear trend from 1950 to 1965. The CFR is the ratio of actual deflated cash flow in quarter t to its trend value.

IBY_t The Industrial Bond Yield in quarter t, the McLeod, Young, Weir index of ten industrial bonds (DB 268).

IBI_t The Industrial Bond Index in quarter t,

$$IBI_t = \sum_{i=1}^{12} IBY_{t-i}/12IBY_t.$$

$10BY_t$ The average yield on government securities of over ten years to maturity in quarter t (DB 2764).

$10BI_t$ The ten-year Bond Index, $10BI_t = \sum_{i=1}^{12} 10BY_{t-i}/12(10BY_t)$.

EY_t Equity Yield in period t, Moss, Lawson ratio of latest declared dividend to current average price of 114 stocks (DB 2765).

EI_t Equity Index in quarter t, $EI_t = \sum_{i=1}^{12} EY_{t-i}/12EY_t$.

BEY_t The Bond/Equity Yield, a combination of IBY_t and EY_t weighted by their respective shares in gross corporate new issues in quarter t.

BEI_t The Bond/Equity Index in quarter t,

$$BEI_t = \sum_{i=1}^{12} BEY_{t-i}/12BEY_t.$$

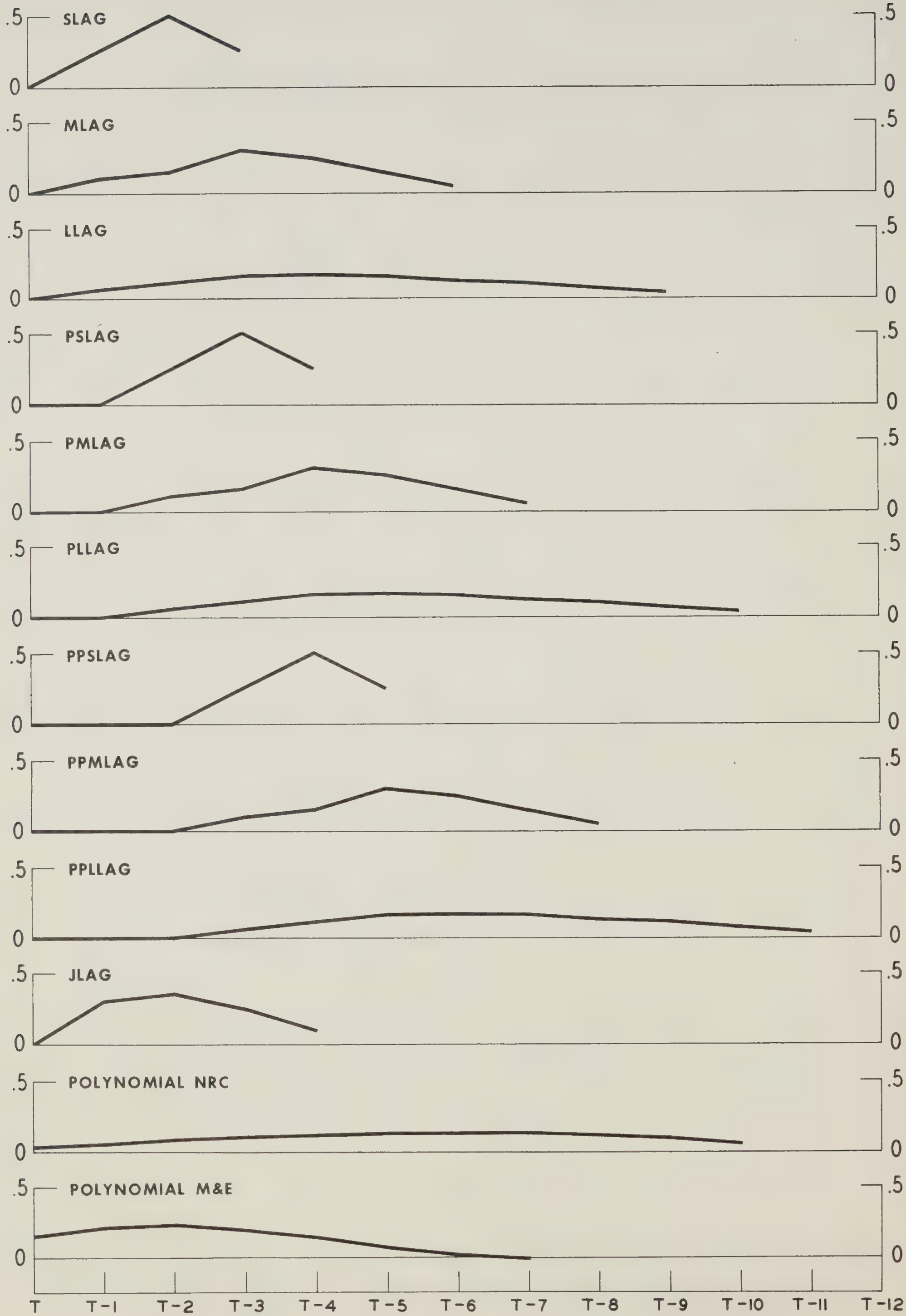
SI_t The index of relative stock prices, calculated by fitting the D.B.S. Index of Industrial Common Stocks, (DB 2597), to a log trend from 1946 to 1965 and then dividing the value of the index in quarter t by its trend value.

CPV_t The Current Policy Variable (see Appendix A) representing the influence of legal depreciation allowances, corporation income tax rates, and the sales tax on construction materials and machinery and equipment, on the cost-of-capital services.

FPV_t The Future Policy Variable (see Appendix A) being the value of CPV to be expected in t plus six quarters on the basis of government policy as announced in quarter t.

Chart 5

PRE-SPECIFIED LAG PATTERNS



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o. 2

BANK OF CANADA
STAFF RESEARCH STUDIES

CANADIAN INVENTORY INVESTMENT

69

R. G. EVANS

SSUED BY THE PUBLICATIONS COMMITTEE OF THE BANK OF CANADA

ERRATUM

Bank of Canada Staff Research Study No. 2.

CANADIAN INVENTORY INVESTMENT

by

R.G. Evans

See p. 37 Equation (2.9)

✓

t values omitted in error on the coefficients of variables

Y_t^P, ΔY_t^P, UI_t and H_{t-1}

Equation should read:

1Q56 - 4Q65 (SOIV)

$$\Delta H_t = \underset{(3.83)}{603.846}\, Q_1 + \underset{(3.37)}{518.098}\, Q_2 + \underset{(0.46)}{53.381}\, Q_3 - \underset{(1.46)}{86.778}\, Q_4$$

$$+ \underset{(2.02)}{.135}\, Y_t^P - \underset{(0.22)}{.030}\, \Delta Y_t^P - \underset{(5.16)}{260.046}\, UI_t - \underset{(2.64)}{.120}\, H_{t-1} \qquad (2.9)$$

SEE = 76.7 $\bar{R}^2$ = .786 D/W = 2.01

CANADIAN INVENTORY INVESTMENT

R.G. Evans

This paper is a report on the research underlying the business inventory investment equations used in RDX1, the experimental aggregate model of the economy being developed at the Research Department of the Bank of Canada. The views expressed are the personal views of the author and no responsibility for them should be attributed to the Bank.

un raffinement à la variable servant à représenter les ventes, en déduisant de la Dépense Nationale Brute toutes les composantes qui ne représentent pas une dépense en biens; en outre, les variables de taux d'intérêt furent divisées par la valeur retardée de leurs moyennes mobiles - calculées sur douze trimestres à pondération uniforme - ce qui donnait, pour représenter le coût de financement des stocks, un indice dépourvu de toute tendance à long terme. L'équation s'est alors améliorée, mais les coefficients des variables de taux d'intérêt sont demeurés non significatifs ou affectés de signes erronés a priori, ou même les deux. D'autres expériences ont été faites en utilisant le rapport entre les prêts en cours accordés aux entreprises et les montants autorisés; cette méthode nous a cependant donné une fonction de demande plutôt que d'offre. Un accroissement des stocks avait tendance à se traduire par une augmentation des autorisations, tandis qu'une réduction de celles-ci n'entraînait pas une compression des stocks.

Comme, de toute évidence, l'évolution des ventes dans le passé ne permettait pas de prévoir de manière satisfaisante le volume des ventes dans l'avenir, on a procédé à de nombreuses expériences avec des variables prévisionnelles basées sur les cours des actions, les bénéfices des sociétés et les taux de chômage. L'utilisation d'un indice de chômage - calculé en divisant le taux courant par la valeur retardée de sa moyenne mobile sur quatre trimestres avec pondération uniforme - a permis d'obtenir les meilleurs résultats. L'utilisation de cet indice a permis d'améliorer sensiblement l'ajustement de l'équation. Cependant, tous les efforts visant à introduire des variables de taux d'intérêt, sous forme réelle ou d'indice, ont été caractérisés par l'insuccès, quelle que soit la méthode d'estimation utilisée. On a, en outre, effectué plusieurs expériences avec des variables de prix, mais les résultats n'étaient pas significatifs. L'équation, sous sa forme finale, présente l'investissement trimestriel en stocks comme étant fonction du niveau courant et de la première différence de la variable servant à représenter les ventes, de l'indice de chômage et de la valeur retardée du stock.

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*Cette étude présente les travaux de recherche à la base de l'équation relative à l'investissement en stocks des entreprises utilisée dans le RDX 1 - modèle économétrique trimestriel de l'économie canadienne construit au Département des recherches de la Banque du Canada. Les opinions exprimées sont celles de l'auteur et n'engagent en rien la responsabilité de la Banque.

TRAVAUX DE RECHERCHE À LA BANQUE DU CANADA

ÉTUDE N°2 - 1969

CANADIAN INVENTORY INVESTMENT*

par

R. G. EVANS

RÉSUMÉ

Cette étude représente une tentative d'intégrer en une seule équation les divers facteurs de causalité qui déterminent le taux d'investissement en stocks des entreprises non agricoles sur une base trimestrielle. Cette équation a été mise au point comme élément du modèle économétrique simultané de l'économie canadienne, RDX 1, élaboré au Département des recherches de la Banque du Canada. Les restrictions imposées par les données et le cadre du modèle RDX 1 ont conduit à l'adoption d'une formulation en une seule équation.

La formation des stocks est représentée par un mécanisme d'accélération flexible; notre discussion porte donc d'abord sur les fondements théoriques de ce concept et sa relation avec la notion de contrôle optimal des stocks. Dans le choix, pour le modèle, d'une structure spécifique qui tienne compte des retards et des attentes, on a accordé une attention spéciale au problème d'identification qui se pose lorsque différentes structures théoriques exigent que l'on estime à partir des mêmes données divers ensembles de paramètres. Même lorsque les estimations obtenues sont identifiables, elles ont tendance à être très instables par suite de légères différences dans l'échantillon. Comme les équations ajustées empiriquement aux mêmes données tendent de toute façon à être presque semblables on a décidé de recourir surtout aux ajustements d'ordre empirique et d'analyser ensuite les coefficients ainsi obtenus afin de déterminer la gamme des structures hypothétiques susceptibles d'être raisonnablement soutenues par l'équation finale.

Notre travail empirique a d'abord porté sur une première spécification visant à expliquer l'investissement en stocks. Les variables explicatives utilisées dans cette relation sont: le niveau des stocks - obtenu par addition cumulative des flux trimestriels à une valeur de base - le niveau trimestriel ainsi que la variation trimestrielle de la Dépense Nationale Brute pour représenter les valeurs actuelle et anticipée des ventes et les taux d'intérêt sur des avoirs à échéances diverses pour mesurer le coût des capitaux immobilisés dans les stocks. L'ajustement de cette formulation s'est avéré peu satisfaisant et les coefficients des variables de taux d'intérêt ont été contraires à nos attentes. On a alors apporté

(Suite au verso)

PREFACE

The experimental econometric model of the Canadian economy developed at the Bank of Canada Research Department, RDX1, has been built up from partial studies of the major sectors of the economy. Results of investigations of quarterly business inventory investment carried out as part of the study of business investment modelled in RDX1 are reported in this paper. Later results, primarily based on single-equation analysis completed in September of 1967, are also included. They were obtained from simultaneous reestimation of the basic equations with the whole-economy model. These consistent parameter estimates are largely in accordance with the conclusions derived from the earlier work.

In this study I attempt to model the behaviour of quarterly business inventory investment within a single equation linking sales proxy variables, expectational variables, and cost-of-finance variables. These finance variables are of primary interest, as they represent the channels through which inventory investment may be influenced by the policy instruments available to the various levels of government. Unfortunately the results of the study in this respect are negative, since no useful evidence of inventory responsiveness to cost-of-finance variables could be found. It is possible that these negative results are due to my focus on aggregate inventories; but the requirements of the simultaneous model, for which the equation was designed, largely dictated this focus. Some analysis of inventories broken down by industry division was attempted in the summer of 1966. However this line of approach was not very successful and was broken off before completion.

The research recorded in this paper was all carried out at the Bank of Canada, and was aided greatly by the environment of

continuous consultation which characterizes the econometric model project. Assistance was received with each phase of the study from so many members of the Research Department that it now seems impossible to acknowledge all this help. Where would one start, or stop? In particular, however, John Helliwell of the University of British Columbia, a Bank of Canada Research Consultant, was a constant source of inspiration and advice while Ian Stewart, as production manager for the whole model, was tirelessly patient with the endless tinkering that went into the equation. Moreover during my absence from the Bank they conducted part of the research here described. To them, and to the others who were involved, should go much of the credit for whatever this study has contributed.

Robert G. Evans
Harvard University

CONTENTS

TABLES

CANADIAN INVENTORY INVESTMENT

1. The Framework of the Study

a) The General Problem

In attempting to specify and estimate a single equation determining Canadian inventory investment on a quarterly basis, I am reminded of those intrepid investigators of an earlier day who set out to hunt the snark. They also were engaged in a venture whose importance was unquestioned, with a quarry whose characteristics were but dimly descried. And like them, I run the risk of eventually finding something looking very like a snark yet being in fact disastrously different in its structural properties. In that case I can only "softly and suddenly vanish away". It is not recorded what happens in the sequel.

The importance of the search is indeed unquestioned. The investment sector of the economy lies at the heart of any econometric model, being both the main source of variance in the behaviour of the private sector and the focus for much of traditional public policy. From the policy point of view, the behaviour of the investment sector is fundamental to the attainment both of short-run stability in the levels of income and employment and of long-run growth through the expansion and technological improvement of productive capacity. In the long-run context, of course, inventory investment is of little consequence compared to investment in plant, equipment, and housing stock. Adding nothing to productive capacity, the swings of inventory investment tend to cancel out over time. But for short-run predictions over several quarters or for the analysis of the short-run impact of policy changes, the behaviour of inventory investment becomes crucial because of its volatility and the substantial size of inventory movements. During the postwar period there have been several quarters in which inventory investment has run at 5 per cent or more of total Gross National Expenditure (GNE), and others in which disinvestment has been between 2 per cent and 3 per cent of GNE. Such sharp inventory movements can account, or more than

account, for total GNE movements between quarters. In recent years inventory movements relative to GNE have been somewhat more moderate, but the absolute swings have often run between a quarter- and a half-billion dollars in constant 1957 dollars per quarter.

In addition to the speed and size of inventory movements, inventory investment has generated a particular concern in its potential as a focus for macroeconomic policy. The hypothesized importance of inventory investment has diminished since the days when R.G. Hawtrey based a whole theory of business cycles on the reaction of trade inventories to changes in the cost of credit. (See Haberler [11] pp. 14-28.) But it is still true that holding inventory ties up capital, and capital costs money whether borrowed or owned. If the inventory-holder borrows to finance his holdings, monetary policy may operate through the cost of funds to make this borrowing more expensive, or through the availability of funds to make further accumulation impossible. If the inventory-holder merely ties up his own capital, rising interest rates will increase the opportunity cost of such holdings, and presumably will discourage them. The mechanism can also be expected to work in reverse, subject to the usual question of whether cheap finance actually encourages borrowing as much as dear finance discourages it. If monetary policy can thus manipulate the optimum level of each holder's inventory, and if his decisions are sensitive to this optimum level, then inventory investment provides a particularly direct means by which monetary policy can influence the levels of investment, income and employment almost independently of the longer-run rates of capacity accumulation and growth, and without the long lags characteristic of the reactions of fixed investment. The appeal of such a rapid and direct channel of policy control is obvious — if it works.

Thus the ideal inventory investment equation, which we should like to build into an aggregate macroeconomic model of the Canadian economy, would provide a good fit to the sharp inventory swings observed over the postwar period, plus a plausible and temporally stable structural form isolating behavioural rather than associative relationships. In addition, an ideal equation should contain in its structure a set of financial variables indicating the extent to which policy makers can influence the level of investment. Unfortunately no one has yet found such an equation — indeed it may very well not exist. Certainly previous attempts to fit a

single equation to Canadian data, usually in the context of an aggregate econometric model, have not met with great success.[1] The fits have been weak and the implied structures at best plausible but not immediately convincing. In general the investigators have been dissatisfied, but, since the primary interest and focus of their work was in other sectors of the economy, they have simply shored up the inventory investment section of the model and concentrated their efforts elsewhere. In the United States considerable work has been done usually with quite elaborate theoretical structures.[2] The reduced forms from such models have tended to be similar, and have yielded good fits but unstable implied structures. Different investigators, working with roughly similar estimating equations, have produced widely divergent estimates of the structural parameters. (See Mack [17] pp. 224-231.) Much of the problem seems to stem from efforts to combine in one equation hypothesized processes of expectations formation and of investment based on expectations. Results may improve with the use of the new data on business expectations now becoming available. (See Foss [9].) But such Canadian data are not presently available nor will they be in the forseeable future, so for us this improvement is cold comfort.

Another line of attack, which may have considerable promise in dealing with this problem, has recently been opened by T.J. Courchene. (See [3] and [4].) He challenges the established assumption that aggregation in inventory analysis does no harm and may be positively beneficial by producing some very interesting results from the analysis of disaggregated data. He examines subsectors of the Canadian manufacturing industry, emphasizing the distinction between those that produce largely to meet orders for specific commodities (Production-to-Order) and those that produce

[1]Inventory equations embodied in simultaneous econometric models of the Canadian economy include Bakony [1], Officer [18], Rhomberg [19], Shapiro [20] and Stewart [21]. Johnson and Winder [12] also attempt to specify a single-equation model.

[2]A review of the earlier literature is included in the survey of investment studies for the Commission on Money and Credit by Eisner and Strotz [8]. Further discussion of the literature and additional results are presented in Lovell [15]. The Brookings Quarterly Econometric Model of the United States contains an inventory investment sector within a simultaneous model framework, Darling and Lovell [6]. More recent is the preliminary work of Lovell using anticipations surveys, Lovell [16].

and accumulate output in anticipation of future sales (Production-to-Stock). In addition, he breaks down inventories in each manufacturing industry by stage of fabrication, and analyzes separately the raw material, goods-in-process, and finished goods components of inventory holdings. Thus one can segregate the different categories of inventory according to the motives for holding each, and so derive a much more stable causal structure.

For a number of reasons this procedure could not be used here. In the first place I had to try to explain all inventory holdings and not simply holdings in the manufacturing sector. But, outside of manufacturing, data by stage of fabrication are not available. This fact limits the application of the Courchene approach in an aggregate model. A more serious difficulty involved in adapting his procedure is that the disaggregated data for manufacturing are available only in current dollars while, to conform to RDX1, my equation had to be fitted in constant dollars. (A check on the equations, described below, showed that at the aggregate level the constant-dollar equations gave a much better fit than equations using current dollars, in spite of the elimination of parallel price movements in dependent and independent variables.) There is a partial breakdown of the manufacturing deflator into durables and non-durables, from 1959 to the present, but this is clearly not enough to work with. In addition, because the data on non-manufacturing inventories are notoriously shaky, it seemed perhaps wiser to pool the errors in variables and hope for some cancellation rather than to try to handle each series separately. Certain experiments were made with the inventories held by non-manufacturing industries, but the results were in general not encouraging. More time and effort spent on these experiments might have led to some sort of breakthrough; however this further endeavour will have to wait for another occasion.

Finally there are sheer size constraints imposed by the need to fit the inventory sector into a simultaneous econometric model. Had I surmounted in one way or another the problem outlined above and arrived at reliable disaggregated inventory equations I should have had an inventory sub-sector of some twenty or so equations. This would represent one-third of the capacity of a very respectable model, and ten per cent of a model even more ambitious than the currently published form of The Brookings Quarterly Econometric Model of the United States. Moreover, the virtue of a disaggregated

approach is that it allows different causal variables for each category of inventory. But in a complete model, each new variable requires its own explanatory equation and so expands the model even further. Unfilled orders, for instance, may play a powerful role in explaining some categories of inventory; but to explain unfilled orders may be no easier than to explain inventory. And one can hardly leave unfilled orders as an exogenous variable. Thus the limitations of data and constraints imposed by the simultaneous model framework led me to stay with the aggregated approach.

The results fall somewhat short of the ideal inventory equations described above, which is not really surprising. I have not succeeded in fitting the data period as well as I should like, although the fits compare quite favourably with previous Canadian experiments. Nor have I been able to match the Americans' ability to generate an $\overline{R}^2$ of .95 on almost anything. The final structure, like the goodness of fit, is satisfactory without being exciting; but I was particularly disappointed in my efforts to introduce financial variables subject to policy control. This disappointing result may have several explanations. Inventory-holders may not be fully 'rational' — through ignorance or inertia they may not take account of the costs of carrying inventory. Alternatively, given the relatively small changes historically observed in such costs, the savings to be derived from optimal inventory management may not justify the effort and expense involved. Where information is costly, 'irrationality' may be rational. And finally the uncertainties surrounding sales and supply considerations may be so great that they swamp any cost-of-funds effects. If businesses could forecast future sales, or even some frequency distribution of future sales, with perfect accuracy they might take account of the impact of financial variables; but in the full uncertainty of the real world such considerations are of decidedly secondary importance. There is some survey evidence to support this view. (See Young and Helliwell [23].)

As for the goodness of fit, it is possible that given the highly expectational nature of inventory investment decisions, there may be a substantial segment of variance that cannot be explained. Such an 'animal spirits' component cannot be fitted into a deterministic structure, or at least not into a structure

that relies on economic causal variables. If we want better-fitting equations, we must wait for operations research techniques of inventory control to spread through the economy. In addition, of course, our equations are subject to all the usual open-economy-type problems: firms' suppliers and/or markets may be outside the country and more or less independent of Canadian economic developments, foreign parents or affiliates may make the costs of financing inventory in Canada irrelevant, and so on. There is no shortage of explanations of why the ideal equation has not yet been found.

b) The Analytic Background

A search for the relevant causal variables bearing upon inventory investment can begin simply by making choices among the many plausible candidates which suggest themselves. It is preferable, however, to start with some hypothesis on the internal structure of the inventory investment decision in order to organize the search and provide a criterion by which to interpret the results. Since the flexible accelerator mechanism is now solidly established in the literature[3] and provides a very logical and satisfying way of organizing the equation, this structure was chosen as a starting point.

The flexible accelerator mechanism is based on the hypothesis that there exists at any time some equilibrium or desired level of inventories H_t^* that, if achieved, would tend to be maintained. Zero inventory investment is thus implied. This level of inventories would be a function of current and expected future sales, the cost of carrying inventory, and a wide variety of other factors. The discrepancy between the desired level and the actual level at the end of period t-1 would be eliminated by investment or disinvestment in this period. For several possible reasons, however, the discrepancy is only partially eliminated in the current period, and the change in inventories is proportionate to the size of this gap. Thus we get the basic formulation:

$$\Delta H_t = b(H_t^* - H_{t-1}) \tag{1.1}$$

[3]The mechanism is derived from Goodwin, [10] and was used in inventory analysis by Darling [5] and subsequently by Lovell, Courchene, and others.

Now H_t^* is of course not directly observable, so it may be represented as a function of various sales and cost variables:

$$H_t^* = f(X_1,...,X_n) \qquad (1.2)$$

These variables in turn include such magnitudes as expected sales, so they are a combination of observable and non-observable variables. For full generality:

$$X_i = g_i(Y_1,...,Y_m) \qquad (1.3)$$

In the event that X_i is an observable variable, $X_i = Y_i$; otherwise X_i must be represented by some combination of observed Y_j whose form is subject to one's hypotheses about expectations formation. Also the distinction may shift depending on the availability of new data. Thus next quarter's expected sales may be measurable in the United States from survey data, but in Canada they may be assumed to be a function of present and past sales — in turn represented by a proxy such as GNE, shipments, or some other observed variable. If, through a heroic (or naive) process of simplification, all functions are expressed linearly the equation is:

$$H_t^* = a_0 + a_1X_1,...,a_nX_n$$

$$X_i = c_{0i} + c_{1i}Y_1,...,c_{mi}Y_m$$

$$\Delta H_t = bd_0 + bd_1Y_1 + bd_2Y_2,..., + bd_mY_m - bH_{t-1} \qquad (1.4)$$

an expression in observable variables susceptible to estimation.

There is, of course, a limit to the number of possible Y_j that can be used for estimation purposes — a limit imposed by available data sources.

But there are few limits on the possible determinants of H_t^* or on the possible functional forms relating these determinants to the available observed variables. Thus most of the efforts to estimate an inventory equation have used roughly similar sets of

Y_j but have derived them from differing definitions of X_i and forms of f and of the g_i. As a simple example, I can define H_t^* as a function of expected sales and the interest rate, and let expected sales be a linear combination of current sales and those of the previous quarter.

$$H_t^* = a_0 + a_1 S_t^e + a_2 r_t \tag{1.5}$$

$$S_t^e = (1 - \rho) S_t + \rho S_{t-1} \tag{1.6}$$ [4]

The estimating equation becomes:

$$\Delta H_t = ba_0 + ba_1(1 - \rho) S_t$$

$$+ ba_1 \rho S_{t-1} + ba_2 r_t - bH_{t-1} \tag{1.7}$$

On the other hand if I assume that inventory investment includes a 'passive' term equal to the deviation between actual and expected sales, the equation is:

$$\Delta H_t = b(H_t^* - H_{t-1}) + (S_t^e - S_t) \tag{1.8}$$

The estimating equation is:

$$\Delta H_t = ba_0 + [ba_1(1 - \rho) - \rho] S_t$$

$$+ [ba_1 + 1] \rho S_{t-1} + ba_2 r_t - bH_{t-1} \tag{1.7'}$$

[4]This form derived from the projection of past levels with a partial prediction of the change,

$$S^e = S_{t-1} + \delta \Delta S_t$$

$$= \delta S_t + (1 - \delta) S_{t-1}$$

$$\text{or } (1 - \rho) S_t + \rho S_{t-1}$$

A discussion of this forecasting form can be found in Theil [22] pp. 154-161.

The equation is unchanged but the interpretation of the coefficients differs. In fact it is not difficult to build models in which the reduced-form estimates will not yield unique values of the structural parameters and the model is underidentified.

The estimated values from the final equation could, of course, be used as a way of distinguishing between different model specifications, given a priori notions of plausible ranges for the model parameters. But this eliminates one of the criteria for choosing a good final form of the estimated equation. Thus a chicken-and-egg problem results in that the model ultimately chosen and the best possible estimating equation have to be jointly selected in a way that weakens most of the statistical tests of significance. The methodological implications of this procedure are at best unclear; but, given the extensive degree of our ignorance about the state of the world, this procedure is undoubtedly superior to marrying oneself to a specific a priori model. Since not enough is known on theoretical grounds to do this, I have fitted equations of form (1.4) with an interpretation that is explicitly as simple as possible within the framework of the flexible accelerator model, and I have interpreted the parameters as well as I could afterwards.

Since the model as outlined above is virtually unrestricted in form and content, I should comment on my interpretation of it and on the considerations which governed the choice of variables for experimentation. To begin with, this type of model rests on the assumption that H_t^*, the desired level of inventories, exists for the whole economy. This assumption can be based on an extension of the well known theory of inventory management developed as a branch of operations research. Given enough information on the actual values or the probability distributions of the relevant variables affecting each inventory-holder, an individual H^* can be derived for him in each time period. Aggregating these H^* yields an optimum level for the whole economy. It is not necessarily true, however, that the optimal inventory strategy located by operations research techniques will define a desired inventory level. In some cases this problem is not serious, as in the two-bin or (S,s) strategy that calls for the firm to reorder up to some level S whenever stocks decline to level s. Here S may be defined as the optimal level and the adjustment coefficient b may be relied on to embody the delayed adaptation of actual in-

ventories to the desired level. But for some inventory models this strategy is not optimal, and at any given time no 'best' level can be defined. A simple example of such a situation is given by Dorfman [7] pp. 45-47.

This problem can be avoided by saying that whatever the 'best' level may be, every inventory-holder has some idea about what his inventories should be. His idea might be no more precise than 'higher', 'lower', or 'unchanged', but some level will satisfy each inventory-holder. In such a case the individual H_t^* is likely to be a band rather than a single value. But from this assumption it does not immediately follow that we can aggregate these individual levels to yield an economy-wide value of equilibrium inventories. It is quite reasonable to assume that the desired inventory levels of all firms are interdependent, quite apart from their dependence on the same exogenous factors. If a firm's suppliers have lower desired inventory levels, then its own desired levels should rise. One could argue that suppliers' actual inventories are more relevant to the firm, as these influence reorder lags; but suppliers' desired levels of inventories will have more significance for the future, and in its inventory policy a firm should take account of this fact.

If the justification of H_t^* for the whole economy on the basis of aggregating micro-values is unacceptable, some more general grounds for its assumption are needed. I can argue that relatively high inventories prompt holders to cut back, and relatively low inventories prompt them to accumulate. This implies that, ceteris paribus, the change in aggregate H_t is a declining function of H_t, taking on positive and negative values. If the function is assumed to be single-valued and continuous, this implies that for some level of H_t the change in H_t is zero. An equilibrium level is established that will, in the absence of changes elsewhere in the economy, tend to perpetuate itself. If the function is also monotonic, there will be a unique and stable equilibrium; otherwise there may be multiple equilibria some of which are unstable. If monotonicity is plausible, I can assume a unique and stable equilibrium level (not necessarily desired) of H_t yielding net inventory investment of zero.[5]

[5]If on the other hand the mapping of $H \to \Delta H_t$ is point-to-set, equilibrium solutions would seem to require restrictions on the nature of the mapping equivalent to the extension from Brouwer to Kakutani fixed-point theorems. (See Lancaster [13] pp. 336-8 and pp. 342-352.)

If the unique macro-level H_t^* is assumed to exist, we may then consider the nature of the reaction coefficient b. Inventories tend to be very volatile and subject to rapid adjustment; so why do not inventory-holders try to eliminate all the gap within the quarter, rather than just a fraction of it? Lovell suggests several reasons [14] pp. 295-296. There may be ordering costs involved in changing the level of inventories, ordering intervals may be infrequent, liquidation of recently acquired stocks may be gradual. These reasons can be summarized in the (S,s) strategy, implying that at any given time most holders are somewhere between S and s stock levels, and will not act to eliminate the gap until the stocks fall to s. The batch cost makes it uneconomic to order at frequent intervals so adjustment will be slow. But this framework involves two types of problems. First of all, the implied reaction time is unlikely to be much longer than a quarter; lags of two or three quarters are not consistent with what is known about the rapid responsiveness of inventory. This implies that b for quarterly data should be quite close to 1.0, certainly above 0.5. Yet 0.5 is not the estimated value in most empirical work, including mine. Secondly, the identification of the upper bound S with H_t^* is also pretty shaky because this rationale implies that each holder is almost always below S and that the economy in total is always below. A desired reduction in inventories does not fit the apparatus. If the (S,s) model is discarded, the delayed reaction may be justified by saying inventory-holders are cautious and do not move to the equilibrium level all at once in case it should shift by the time they get there. Another possible rationale is that total inventories adjust slowly, because one firm's disinvestment is another firm's investment, and if all firms try to change their inventories at once in the same direction all will be more or less unsuccessful. Again, however, long lags are hard to justify by this explanation. So given the very long implied adjustment lags derived from most empirical work, there may be suspicion about whether the model is measuring the right thing.

If misgivings about the definitions of H_t^* and b are ignored, attention must be turned to the determinants of H_t^*. These can be subdivided into positive and negative categories — the reasons for holding inventory and the costs of doing so. In the positive category, clearly the desired variable is expected sales. Whatever the class of inventory and whatever the industrial

division, all inventory is held for contribution to future sales. In a complete model the desired level of inventory should also depend on the probability distribution of future sales, or at least on the standard error; but at the level of macro-aggregates these concepts are hard to define. Expected sales are not available in the data set, therefore some hypothesis is required about the process of expectations formation by which expected sales are generated from presently observable variables such as: current and past sales, new orders, and unfilled-order backlogs. Data on the last two variables are available for the manufacturing sector only; no explicit sales data exist for any sector. Sales data may be approximated quite well in the manufacturing sector by shipments, but for the whole economy some estimate must be developed from GNE or Gross Domestic Product, or elsewhere. The new-orders variables and unfilled-orders variables have the advantage of being explicitly related to future sales but these variables are incomplete in coverage and involve either the use of a partially disaggregated model, with manufacturing and non-manufacturing sectors, or else the assumption that such variables from the manufacturing sector have an equivalent impact on non-manufacturing inventories. Moreover, new-orders and unfilled-orders variables would require separate determining equations and would create extra difficulties for a complete model. Unfilled orders have the additional difficulty of being causally ambiguous because any delay in production will lead to a simultaneous increase in work-in-progress inventory and to unfilled orders in the case of industries producing to order. The resulting relation is associative rather than causal. GNE-based proxies for current sales, while convenient in a simultaneous model, necessitate explicit hypotheses concerning expectations formation. The parameters of these hypotheses must be calculated, along with those of the accelerator relation, from the estimated coefficients of whatever equation is finally derived.

The costs of carrying inventory (apart from the physical elements of storage cost, wear, depreciation, and so on) are the costs of the financing necessary to pay for the inventory. Thus some type of interest or discount rate must be introduced to represent the marginal cost of funds to the inventory-holder — a cost variable subject to all the usual problems of discount rates in an imperfect capital market. Is the relevant rate short-term, such as the treasury bill rate, measuring the opportunity cost of

funds tied up in inventory? Should the rate be the industrial bond yield, the average (rather than marginal) cost of borrowed funds to the firm? The bank loan rate may be the average cost of short-term funds, but it is far from being the marginal rate and has little variance anyway. Does the firm have some concept of the internal short-term discount rate, less volatile than the bill rate, incorporating various risk elements as well? For that matter, as suggested above, the historical fluctuations in borrowing costs may be altogether too small relative to the great uncertainties surrounding other determinants of desired inventory. In this case, measures of credit availability or credit rationing may indicate the impact of infinite marginal borrowing costs that are not represented in market interest data. In the face of such uncertainties one can only try various combinations of cost and availability measures to see how they perform.

Further influential variables are limited only by the imagination of the researcher, but one commonly suggested variable is price change as represented by combinations of past price movements. This rests on the hypothesis that firms will build up inventory if prices are expected to rise and cut back if they are expected to fall — a hypothesis usually combined with an extrapolative expectations mechanism. But results with this variable are generally unsatisfactory, and mine are no exception. This could be due to the weakness of the price data, or because the expectations mechanism is inadequate. It could also be because firms consider that they are in business to produce and sell goods, not to speculate on price movements. If they buy in fluctuating markets, they are more likely to cover with forward contracts and 'dis-speculate' than to play the market. Another variable used with some success in the American studies is the size of defence expenditures, recognizing the long lags and large work-in-progress elements in defence procurement. Given the relative size of the Canadian military establishment, however, this variable does not seem worth importing.

Yet another category of variables might be introduced by admitting explicitly that inventory investment depends largely upon how businessmen 'feel' about the state of the economy, and by searching for variables such as unemployment rates and share prices, that are likely to be widely observed and to condition the psychological climate in which inventory decisions are made.

Some success was achieved in this study with transformations of such variables.

One might also question whether the model outlined in (1.1) to (1.4) is complete because this implies that all inventory investment is in some sense deliberate. Yet clearly misforecasting of sales does occur, and may lead to unplanned accumulation or reduction of inventories unrelated to equilibrium or past stock levels. This can be handled by including all such unplanned elements in an error term — (1.4) can hardly be expected to fit exactly! A more involved theoretical formulation, which boils down to the same estimating relation, assumes an unplanned element in accumulation which is proportionate to the forecasting error:

$$\Delta H_t = b(H_t^* - H_{t-1}) + c(S_t^e - S_t) \qquad (1.8')$$

The parameter c is the production inflexibility coefficient. It is zero if production can be fully adjusted within the quarter so that the 'unexpected' sales changes can be met without affecting inventory levels, and 1.0 if production cannot be adjusted within the quarter and all the error is reflected in unplanned inventory change.

If this model is combined with (1.5) and (1.6) it reduces to:

$$\Delta H_t = ba_0 + [ba_1 - \rho(ba_1 + c)]\, S_t$$

$$+ (ba_1 + c)\, \rho S_{t-1} + ba_2 r_t - bH_{t-1} \qquad (1.7'')$$

Again, the equation to be estimated is unchanged but now it is impossible to distinguish between c and ρ, so the model is underidentified. I have some a priori information about each, but hardly enough to be confident in my estimates. And the more parameters to be derived from a given reduced form, the more sensitive is the model to errors of specification and estimation. There is also the theoretical question of whether it is appropriate to 'tack on' the forecast error in this way. The discussion of the formation of H_t^* and of the adjustment mechanism suggested that these might embody some form of optimal inventory strategy. Without being too precise, it can be said that end-of-period target inventory may be dependent on the relation between actual and

expected sales. One of the motives for carrying inventory is to provide a buffer stock so that unexpectedly large sales can be met without disrupting the production process. Since inventories have this production-smoothing function, the inventory target is in fact a range, with each value assuming a different level of actual sales. Thus, the 'unplanned' component is already included implicitly in the equilibrium level — not an additional factor independent of the target inventory. This implies that (1.5) is an inadequate specification, something I certainly do not deny. But the estimation problem is unchanged, and there does not seem to be any theoretical justification for grafting an 'unplanned' investment term onto the model.

2. Estimation Results

In presenting these results I have adopted the philosophy that the cataloguing of failure is almost as important as the description of final success. ('Success', of course, is a relative term.) From the point of view of economic science it is important to present this work in as complete and reproducible a fashion as possible, however galling that record may be. One of the most valuable products of the exercise may then become the information it yields on unfruitful approaches — other researchers can thus avoid these blind alleys. Better still, they may see light where I saw only darkness and discover that it was the researcher who was blind. (Better from the point of view of economic knowledge, not from my point of view.) Therefore I have recorded the results in considerable detail (both good and bad), marking as clearly as possible the pattern followed.

The dependent variable throughout the research was the quarterly change in Canadian non-farm inventories, in constant 1957 dollars seasonally unadjusted (Databank (DB) 150, see [24]). The basic data period was first quarter 1947 to fourth quarter 1965, but most equations were fitted over shorter periods both to avoid what appeared to be structural shifts in the earlier years and to examine potential explanatory variables not available earlier in this period. The model used required a series for inventory stocks as well, which were constructed by cumulating inventory change onto a base-period value for end of fourth quarter 1955 supplied by the Dominion Bureau of Statistics. Since sea-

sonally unadjusted data were used, (1.1) was reformulated:

$$\Delta H_t = Q_1 + Q_2 + Q_3 + Q_4 + b(H_t^* - H_{t-1}) \qquad (2.1)$$

where the Q_i are quarterly seasonal dummies. Since the specification of H_t^* can lead to a constant term, one of the seasonals must be dropped in estimation.

a) First Phase: Estimation with Gross National Expenditure

As outlined above, the experiments began with the idea that the production-smoothing role of inventory should lead to a direct impact of sales-forecast errors on the equilibrium inventory level. Consequently I hypothesized that businessmen have some idea of the 'normal' level of sales, and deviations from this level are partially reflected in H_t^*. This leads to the formulation:

$$H_t^* = c + dS_t^e + e(S_t^* - S_t) + fr_t \qquad (2.2)$$

Here S_t^e is expected sales, S_t^* is 'normal' sales, and r_t is some measure of the cost of funds. Clearly the linear specification of r is rather unsatisfactory, but given the highly uncertain nature of the structure and the difficulties of a non-linear approach it seems a reasonable compromise. The 'normal' level of sales was derived by fitting quarterly GNE (DB 157) in logs to a time trend from 1947 to 1965. The calculated value of GNE was selected as the 'normal' level. Although the use of GNE for a sales proxy is dubious, it has the advantage of ready availability in a small simultaneous model and so seemed to be a point where experimentation could reasonably begin. More refined variables than those used here should lead to better results but not to qualitatively different ones.

Businessmen's sales expectations were modelled in two ways, first by the form outlined in (1.6) and second with a Koyck-type distributed lag of the form:

$$S_t^e = (1 - \lambda)\ [S_t + \lambda S_{t-1} + ,\ldots,\ \lambda^n S_{t-n}] \qquad (2.3)$$

These forms differ very little for λ and ρ with both close to zero but (2.3) implies a much greater importance for sales in the

more distant past if λ is close to 1.0. Smaller parameters imply better forecasting by inventory-holders.

Each of the expectations structures implies a different estimating model. Bringing together (2.1), (2.2), and (1.6), the equation is:

$$\Delta H_t = (Q_1 + Q_2 + Q_3 + bc) + [bd(1 - \rho) - be]\ S_t$$

$$+ bd\rho S_{t-1} + beS_t^* + bfr_t - bH_{t-1}$$

Substituting GNE (Y_t) for sales, and noting that $Y_t = \Delta Y_t + Y_{t-1}$:

$$\Delta H_t = (Q_1 + Q_2 + Q_3 + Q_4 + bc) + b[d(1 - \rho) - e]\ \Delta Y_t$$

$$+ b(d - e)\ Y_{t-1} + beY_t^* + bfr_t - bH_{t-1} \qquad (2.4)$$

This is an estimating equation in observable variables whose coefficients are fully identified.

Substituting (2.3) for (1.6), going through the familiar Koyck transformation, and letting $\lambda \Delta H_{t-1} = \lambda H_{t-1} - \lambda H_{t-2}$, we obtain:

$$\Delta H_t = (1 - \lambda)(Q_1 + Q_2 + Q_3 + bc) + [bd(1 - \lambda) - be]\ Y_t$$

$$+ be\lambda Y_{t-1} + (be - be\lambda k)\ Y_t^* + bfr_t - bf\lambda r_{t-1}$$

$$- (b - \lambda)\ H_{t-1} - \lambda(1 - b)\ H_{t-2} \qquad (2.5)$$

Since Y_t^* is a log trend, $Y_{t-1}^* = kY_t^*$ where $0<k<1$. Equations (2.4) and (2.5) are the initial estimating equations.

Equations (2.4) and (2.5) were fitted over varying time periods using several alternatives for r_t. I tried the three-

month treasury bill rate (DB 601), the average rate on Government of Canada bonds due in less than three years R03 (DB 1365), and the average rate on Government of Canada bonds due or callable in ten years or more RLC (DB 2764) to cover a range of possible terms to maturity; but failed to find significant differences between these alternatives. The results are shown in Tables 1 and 2.

Table 1 indicates clearly that the specification used is inadequate. The 'normal' sales level variable is uniformly insignificant and varies in sign. Worse, the interest variables are all moderately significant but have the wrong signs. While inventories may well perform a 'buffer stock' function the equation does not show this. Weaknesses in the overall equation structure may prevent interest rates from playing their proper theoretical role; certainly they have no place in this formulation.

On the other hand, the coefficients of ΔY_t, Y_{t-1}, and H_{t-1} are significant and relatively stable. This stability extends to H_{t-2}, which was accidentally included in certain of the regressions in place of H_{t-1}. Since in general $H_{t-2}<H_{t-1}$ one might expect H_{t-2} to have a larger coefficient, but the accelerator mechanism suggests that the coefficient should be smaller and this is in fact the case. Implied values of b can be derived from the coefficient of H_{t-2}. These are shown in Table 1 and tend to be somewhat larger than the measured coefficients of H_{t-1}. Only in one case is b undefined.

In deriving the values of the model parameter from these coefficients it can be seen that d, the target marginal stock/sales ratio, lies between 0.5 and 1.0, with the H_{t-2} equations yielding the lower values. The value of ρ is small, suggesting that most of the change in sales is correctly forecast. In the short-period equations beginning in 1955, however, the implied forecast is an overestimate. Examination of residuals from the long-period equations suggests that sharp inventory movements in 1956 and 1957 may be distorting the regression plane of the short-period equation, leading to better fits but less reliable structures. Such a conclusion can hardly be based on the Table 1 results alone, but these results do suggest that a long-period equation may be better. This is confirmed by the general similarity between the coefficients of the 1947-1965 and 1952-1965 equations, a similarity borne out in later experiments. The markedly

TABLE 1

Lovell-type Expected Sales

(Equation 2.4)

	Q1	Q2	Q3	Q4	ΔY_t	Y_{t-1}	Y^*_t	RLC	RTB	R03	H_{t-1}	H_{t-2}	d	ρ	b	SEE	$\bar{R}^2$	D/W
3Q47	501.66	236.45	-.85	131.68	.165	.220	-.018	46.29				-.226	.586	.272	.345	103.4	.517	2.24
4Q65	(5.85)	(2.72)	(0.01)	(1.40)	(3.64)	(4.24)	(0.29)	(1.27)				(4.54)						
1Q55	587.41	107.63	-135.39	189.85	.254	.242	-.028	67.17				-.245	.500	-.056	.429	76.6	.765	1.82
4Q62	(2.36)	(0.42)	(0.44)	(0.63)	(3.51)	(3.13)	(0.32)	(1.58)				(3.43)						
1Q55	624.81	162.60	-58.68	195.29	.228	.244	-.057	74.55				-.228	.531	.086	.354	76.5	.773	2.05
4Q65	(4.04)	(1.03)	(0.32)	(1.17)	(3.67)	(4.58)	(0.72)	(2.18)				(3.47)						
1Q52	577.33	316.82	44.55	166.18	.160	.217	.027			32.45	-.260		.938	.234	.260	89.1	.658	1.66
4Q65	(4.30)	(1.83)	(0.26)	(1.05)	(3.79)	(4.30)	(0.42)			(1.84)	(3.47)							
1Q52	607.38	269.06	105.81	257.95	.143	.163	.062			26.36		-.245	.524	.089	.429	88.9	.659	2.20
4Q65	(3.80)	(1.69)	(0.57)	(1.45)	(3.38)	(3.39)	(0.85)			(1.51)		(3.51)						
1Q55	543.65	75.68	-120.91	180.88	.222	.200	.055		18.44			-.254	1.004	-.086	?	78.5	.753	1.79
4Q62	(2.12)	(0.29)	(0.36)	(0.56)	(2.97)	(2.21)	(0.66)		(1.12)			(3.49)						
1Q55	643.11	193.32	44.97	278.07	.182	.175	.040		22.89			-.232	.927	-.033	.366	78.7	.760	1.97
4Q65	(4.03)	(1.20)	(0.25)	(1.62)	(3.13)	(3.59)	(0.59)		(1.60)			(3.44)						
3Q47	614.30	409.77	105.51	210.20	.172	.249	-.010		22.92		-.255		.937	.322	.255	104.1	.511	1.69
4Q65	(5.48)	(3.37)	(0.89)	(1.78)	(3.81)	(4.43)	(0.18)		(1.38)		(4.47)							

TABLE 2

Koyck-type Expected Sales

(Equation 2.5)

	Q1	Q2	Q3	Q4	Y_t	Y_{t-1}	Y^*_t	R_t	R_{t-1}	H_{t-1}	H_{t-2}	SEE	$\bar{R}^2$	D/W
								(R03)						
2Q52	623.64	300.40	76.90	245.67	.160	.022	.044	29.70	.679	-.149	-.098	88.7	.666	1.83
4Q55	(3.68)	(1.63)	(0.40)	(1.36)	(3.62)	(0.42)	(0.60)	(1.04)	(0.02)	(1.01)	(0.72)			
								(RLC)						
3Q47	538.94	305.82	16.21	130.26	.179	.079	-.030	37.28	17.42	-.130	-.126	104.2	.510	1.98
4Q65	(5.62)	(2.74)	(0.16)	(1.37)	(3.63)	(1.46)	(0.45)	(0.42)	(0.18)	(1.02)	(1.14)			
								(RLC)						
1Q55	589.80	39.63	-66.85	311.12	.212	-.081	.021	141.01	-97.65	.214	-.395	78.2	.755	2.07
4Q62	(2.24)	(0.15)	(0.20)	(0.91)	(2.50)	(0.83)	(0.21)	(1.43)	(0.88)	(0.91)	(2.06)			
								(RLC)						
1Q55	592.54	117.80	-67.45	194.71	.212	.0002	-.035	110.79	-49.53	.050	-.260	78.5	.761	2.11
4Q65	(3.47)	(0.61)	(0.35)	(1.10)	(2.98)	(0.002)	(0.39)	(1.33)	(0.50)	(0.28)	(1.67)			
								(RTB)						
1Q55	564.12	46.68	-79.90	255.44	.210	-.058	.061	22.62	-7.37	.137	-.355	81.3	.735	2.04
4Q62	(2.02)	(0.17)	(0.22)	(0.70)	(2.63)	(0.62)	(0.68)	(0.91)	(0.31)	(0.65)	(1.96)			
								(RTB)						
1Q55	617.15	142.90	23.50	270.23	.179	-.020	.039	27.31	-8.25	.069	-.281	80.8	.747	2.11
4Q65	(3.53)	(0.74)	(0.12)	(1.46)	(2.95)	(0.29)	(0.56)	(1.17)	(0.35)	(0.42)	(1.86)			

better fit of the 1952-1965 equation is probably due to its avoidance of the Korean War inventory boom in 1950 and 1951.

Thus some information can be gleaned from Table 1: the accelerator structure may be useful, the cost variables in their present form are no use, and the 1952-1965 period may be optimal. But no further information can be derived from Table 2. Here again Y^* is insignificant, and all the interest rate variables are wrongly signed. According to the structure of (2.5) the lagged rates should have positive coefficients. The structural parameters in this form are overidentified and different estimates of the same parameter do not converge. Multicollinearity reduces the significance of almost all parameters. The implied values of the reaction coefficient b are quite unstable — one case yields a large negative result. The values of d, the target stock/sales ratio, are even worse. It appears that the Koyck lag structure introduces too many collinear variables and contributes nothing to the usefulness of the model. Further examination of the parameter values implied by these equations does not change this conclusion.

b) Second Phase: The New Sales Variable

It seemed fairly clear that substantial improvements were required in the specifications either of structure or of estimating variables. And since most changes in theoretical structure had little impact on the estimating equation, priority was given to the latter. First an improved sales proxy was developed from the *National Accounts*[6] by taking the sum of: expenditures on consumer durable and non-durable goods (DB 141, DB 140), business gross fixed capital formation (DB 144), total government non-wage expenditure on national accounts basis (DB 2171, DB 4079, DB 4104), and exports less imports (DB 153, DB 154). The resulting variable was thought to be a much closer approximation to actual sales of goods by Canadian inventory-holders than was the GNE used initially and as such to be a more relevant measure of expected pressures on inventories. This variable was denoted as 'purged' GNE or Y^P.

[6] *National Accounts Income and Expenditure* issued quarterly and annually by the Dominion Bureau of Statistics.

The variable for cost of funds was also changed, because it appeared that the strong positive trend in interest rates in the postwar period together with the rising level of inventories might be creating part of our problem. If the interest rate is influential, not as an absolute magnitude but as an index of the relative cost of funds, the trend component should be removed. Thus the interest index is defined:

$$i_t = [\sum_{j=1}^{12} r_{t-j}]/12r_t \tag{2.6}$$

This index can be interpreted not only as the relevant magnitude, if interest rates are important only relative to their recent levels; but also as a measure of credit stringency, on the hypothesis that inventory-holders do not react to cost levels but do react when their sources of funds dry up entirely. We are assuming that the 'fringe of unsatisfied borrowers' moves with relative, not with absolute, interest rates — a fairly safe assumption.

The equation fitted under these hypotheses can be derived from (2.1), (1.5) and (1.6) with Y_t^P substituted for S_t.

$$\Delta H_t = (Q_1 + Q_2 + Q_3 + bc) + bd(1 - \rho)\, Y_t^P$$

$$+ bd\rho Y_{t-1}^P + bei_t - bH_{t-1}$$

or grouping with $Y_{t-1}^P = Y_t^P - \Delta Y_t^P$,

$$\Delta H_{t-1} = (Q_1 + Q_2 + Q_3 + bc) + bdY_t^P$$

$$- bd\rho\Delta Y_t^P + bei_t - bH_{t-1} \tag{2.7}$$

This equation was estimated from 1953 to 1965 in three forms, one with no cost-of-funds term, one with R03, and one with RLC, both interest rates in index form. The results are shown in Table 3. The first obvious point is that the interest index is no help here either. It should be positively signed, but it is negative in both equations. The RLC index is insignificant and weakens the equation fit; but R03, which on a priori grounds might be more

TABLE 3

'Purged' GNE and Interest Index

(Sample Period: 1Q53 to 4Q65)

$$\Delta H_t = \underset{(1.80)}{-208.26} + \underset{(0.85)}{105.91}\, Q_1 + \underset{(2.86)}{271.67}\, Q_2 + \underset{(1.71)}{93.22}\, Q_3$$

$$+ \underset{(3.04)}{.225}\, Y_t^P - \underset{(3.14)}{.295}\, \Delta Y_t^P - \underset{(2.42)}{.119}\, H_{t-1}$$

SEE = 99.4 $\bar{R}^2$ = .596 D/W = 1.23

$$\Delta H_t = \underset{(0.63)}{-82.58} + \underset{(0.78)}{94.28}\, Q_1 + \underset{(2.53)}{237.92}\, Q_2 + \underset{(1.55)}{82.60}\, Q_3$$

$$+ \underset{(2.55)}{.189}\, Y_t^P - \underset{(2.95)}{.272}\, \Delta Y_t^P - \underset{(2.00)}{.098}\, H_{t-1} - \underset{(1.90)}{105.10}\, R03$$

SEE = 96.7 $\bar{R}^2$ = .618 D/W = 1.38

$$\Delta H_t = \underset{(0.40)}{-75.26} + \underset{(0.92)}{115.86}\, Q_1 + \underset{(2.77)}{264.48}\, Q_2 + \underset{(1.62)}{88.63}\, Q_3$$

$$+ \underset{(2.97)}{.221}\, Y_t^P - \underset{(2.99)}{.284}\, \Delta Y_t^P - \underset{(2.35)}{.116}\, H_{t-1} - \underset{(0.91)}{141.91}\, RLC$$

SEE = 99.6 $\bar{R}^2$ = .594 D/W = 1.24

relevant, is moderately significant and improves the equation slightly. Unfortunately its causal implications cannot be accepted.

These equations provide little support for the basic structural model. The implied value of b is so low that it can be rejected on a priori grounds — it yields implausibly slow reaction times. This coefficient may measure the generally depressing effect of past inventory levels on this year's rate of accumulation, but it does not look much like a reaction coefficient. Moreover the implied value of d is about two, and that of ρ between one and two; neither of which goes down very well with our basic model. The value of ρ implies systematic error in the estimates of the change in the direction of sales; that of d implies that for every unit increase in the number of items they expect to sell, firms try to expand inventory by two items. Neither value is very plausible. The trouble may stem in part from decisions made in the first quarter, when inventories are built up in expectation of sales in the second quarter rather than based on actual sales in the first and fourth quarters of the previous year. It is possible that the strong seasonality in the data is too much for the theoretical model to encompass.

I did, however, find substantial support for the procedure of fitting in constant dollars at this point. A set of equations similar to those of Table 3 was run on current-dollar data, and resulted in a markedly lower fit with almost all coefficients insignificant including the quarterly dummies. It seemed fairly well established that the constant-dollar approach was appropriate.

Starting with the basic structure in the Table 3 equation, various forms of cost-of-funds and expectations variables were tested in an effort to capture some of the strong swings that the basic model bypassed. The results of some of these efforts are shown in Table 4. To get at the impact of credit conditions, I introduced the variable $(L/A)_t$, which is the ratio in period t of total business loans outstanding (DB 687) to the level of loan authorizations provided by the banking system (DB 608). The hypothesis is that when businesses start to run up against the limits of their lines of credit, they tend to cut back on inventories in an effort to conserve borrowing capacity. If inventory-holders behave in this way, (L/A) should come in with a negative

TABLE 4

'Purged' GNE with Loans/Authorizations (L/A) Ratio, Stock Index and Applications/Vacancies (APP/VAC) Ratio

	Constant	Q1	Q2	Q3	Y^P_t	ΔY^P_t	$(L/A)_t$	$(L/A)_{t-1}$	H_{t-1}	$STOCK_t$	$(APP/VAC)_t$	$(APP/VAC)_{t-1}$	EQR_t	SEE	$\bar{R}^2$	D/W
3Q56	-561.11	65.22	136.57	25.22	.137	-.234		3.48	-.047					96.7	.629	1.21
4Q65	(1.32)	(0.36)	(1.01)	(0.38)	(1.43)	(1.91)		(0.73)	(0.69)							
3Q56	-1,159.51	69.91	151.66	11.22	.183	-.261	11.61		-.072					87.7	.694	1.38
4Q65	(3.15)	(0.43)	(1.32)	(0.19)	(2.15)	(2.38)	(2.66)		(1.19)							
2Q47	-5.48	-48.96	169.50	69.31	.104	-.280			-.057	2.82				108.9	.461	1.36
4Q65	(0.08)	(0.56)	(2.61)	(1.63)	(1.62)	(4.49)			(1.36)	(2.20)						
1Q52	-256.56	2.20	258.59	94.97	.184	-.326			-.085	2.58				93.6	.622	1.48
4Q65	(2.57)	(0.02)	(3.05)	(2.00)	(2.55)	(4.18)			(1.76)	(2.02)						
3Q56	-350.25	-18.54	-23.43	-31.01	.008	-.160			.044	4.08				86.5	.703	1.72
4Q65	(2.12)	(0.11)	(0.20)	(0.51)	(0.09)	(1.47)			(0.68)	(2.85)						
3Q56	143.97	-50.10	-54.47	-104.79	.026	-.203			-.005		-5.44			85.2	.712	1.64
4Q65	(0.68)	(0.31)	(0.45)	(1.51)	(0.31)	(1.94)			(0.08)		(3.05)					
3Q56	-11.96	66.91	175.49	15.29	.049	-.227			-.014			-5.92		83.2	.725	1.52
4Q65	(0.07)	(0.43)	(1.60)	(0.27)	(0.63)	(2.21)			(0.25)			(3.35)				
2Q52	-22.43	-5.93	159.08	11.03	.141	-.303			-.067		-4.21			90.9	.649	1.57
4Q65	(0.20)	(0.05)	(1.68)	(0.19)	(1.92)	(3.68)			(1.40)		(2.69)					
2Q52	-127.47	82.80	304.30	86.83	.116	-.298			-.046			-5.89		85.2	.691	1.59
4Q65	(1.33)	(0.79)	(3.99)	(1.99)	(1.70)	(3.86)			(1.03)			(3.83)				
2Q52	-352.50	45.59	269.79	76.08	.088	-.292			-.024			-5.47	183.37	83.7	.702	1.79
4Q65	(2.12)	(0.43)	(3.47)	(1.75)	(1.27)	(3.84)			(0.53)			(3.56)	(1.64)			

sign and preferably with a lag. It would form a very clear channel for policy even if businesses were insensitive to interest rates.

Unfortunately, as can be seen in Table 4, (L/A) comes in strongest currently and with a positive sign. Clearly I have identified a demand for loans, not a supply relation, and shown that when business inventories are rising, firms tend to borrow more. If this is true, then credit constraints may inhibit inventory growth; but not through the structure suggested in the equation. This equation was only tested from 1956 to 1965 because the data on authorizations are not available before that date.

Efforts were also made to include as expectational variables the difference between the Toronto Stock Exchange common stock index (DB 2597) and its log trend 1946 to 1965 $STOCK_t$; the ratio of the index to its trend EQR_t; and the ratio of unplaced applicants to unfilled vacancies in all industry divisions $(APP/VAC)_t$ (DB 3979, DB 3965). As can be seen in Table 4 these variables all enter with the correct sign but tend to weaken the other variables in the equation and to help the fit only marginally. Moreover, none of the expectational variables included have a particularly good theoretical justification, unless they are indeed relevant to the formation of businessmen's expectations about the state of the economy.

One expectational variable which is widely watched, however, is the unemployment level (DB 1202, DB 1203). Although it has less variance than $(APP/VAC)_t$, the unemployment level is, with Gross National Product, probably the best known of the major economic aggregates. Rapidly and easily available to the public, the level of unemployment is generally accepted as an indicator of business conditions. But it is not clear in what form the variable should be introduced into these equations. Do inventory-holders look at the level of unemployment, recent changes in that level, the level relative to recent changes, or what? With these questions in mind, four new variables were defined to enter the inventory equation: U_t is the average level of unemployment over the quarter, ΔU_t is the current first difference in the level, U_t/U_{t-4} is the ratio of this quarter's level to the same quarter last year, and UI_t is a ratio of the current level divided by a

twelve-quarter moving average with equal weights given to the levels from t-1 to t-12.

The results of computations using these variables are shown in Table 5, and they are distinctly interesting. Neither U_t nor ΔU_t contributes much to the equation fit — both weaken the coefficients of other variables. But U_t/U_{t-4} and particularly UI_t produce substantial improvements in fit while the other variables in the equation hold up well. On all the standard tests of equation quality, Durbin/Watson (D/W) statistic, Standard Error of Estimate (SEE) and so on, the UI_t equation for both 1952-1965 and 1956-1965 is a considerable improvement over any of its predecessors. Whereas before, the presence of autocorrelation had to be accepted with a 5 per cent confidence level, now for the 1952-1965 equation the hypothesis can be rejected at a 5 per cent level. Moreover, the standard errors of all coefficients are reduced. It would appear that the level of unemployment relative to its average over the last twelve quarters (roughly a full business cycle) captures part of the process of expectations formulation about the general state of the economy to which businesses react in setting their inventory targets.

The equation with a UI_t term fitted from 1956 to 1965 also may contain some confirmation of the flexible accelerator structure. It implies quite a low b. But the near equality of the Y^P_t and ΔY^P_t terms might imply that both are only part of a Y^P_{t-1} term with a marginal stock/sales ratio somewhat greater than one. If expected current sales are some ratio to last quarter sales, a ratio greater than one, this yields a marginal stock/sales ratio near one. Then businesses project current sales as a per cent rise on last quarter; and target end-of-quarter inventories are, on the average, equal to next quarter's expected sales. The structure is quite plausible except for the very slow implied rate of adjustment. Still, this equation allows for a more sensible interpretation of all coefficients than any other located so far. Consequently I accept the last two equations of Table 5 as a new 'basic model'.

c) Extensions of the Basic Model

If the new equation is better specified as to structure than were the previous ones, it is possible that a priori significant

TABLE 5

'Purged' GNE with Unemployment-based Expectations Variables

	Constant	Q1	Q2	Q3	Y^P	ΔY^P	U_t	ΔU_t	U_t/U_{t-4}	UI_t	H_{t-1}	SEE	$\bar{R}^2$	D/W
1Q52 4Q65	-254.32 (2.56)	-0.38 (0.00)	236.27 (2.69)	64.02 (1.23)	.120 (1.38)	-.331 (4.27)	-.404 (2.12)				-.029 (0.47)	93.2	.625	1.48
1Q56 4Q65	97.58 (0.62)	171.92 (1.25)	-15.58 (0.14)	-89.51 (1.39)	-.028 (0.29)	-.121 (1.22)	-.755 (3.52)				.045 (0.66)	87.9	.718	1.39
1Q52 4Q65	-243.89 (2.24)	56.57 (0.52)	334.51 (3.17)	130.42 (2.02)	.241 (3.41)	-.331 (3.91)		.135 (0.41)			-.126 (2.74)	97.3	.592	1.21
1Q56 4Q65	-13.77 (0.08)	294.56 (1.84)	15.34 (0.10)	-72.20 (0.77)	.174 (2.00)	-.169 (1.49)		-.540 (1.28)			-.101 (1.69)	101.0	.628	1.31
1Q52 4Q65	59.42 (0.49)	-0.87 (0.01)	262.28 (3.44)	98.12 (2.26)	.175 (2.71)	-.322 (4.46)			-142.97 (3.56)		-.097 (2.34)	86.7	.676	1.86
1Q56 4Q65	335.26 (2.00)	154.70 (1.21)	100.81 (1.03)	5.25 (0.10)	.133 (0.10)	-.167 (1.89)			-196.51 (4.42)		-.091 (1.89)	81.6	.757	1.73
1Q52 4Q65	185.84 (1.55)	143.91 (1.58)	250.96 (3.58)	38.13 (0.90)	.155 (2.60)	-.300 (4.50)				-211.46 (4.89)	-.092 (2.43)	79.6	.726	1.85
1Q56 4Q65	546.63 (3.29)	342.47 (3.00)	160.45 (1.83)	-37.33 (0.77)	.158 (2.53)	-.179 (2.18)				-269.90 (5.67)	-.126 (2.91)	73.1	.805	1.70

variables formerly of no use might now enter the equation in an appropriate manner. With this in mind I attempted to reintroduce the R03 bond yield in index form. It had the wrong sign and was insignificant, weakening the equation. But at least the new specification no longer draws assistance from wrongly signed cost variables. I also tried the treasury bill yield previously used in the first testing phase RTB (DB 601), the industrial bond yield (McLeod, Young, Weir IBY (DB 268)), and the yield on a sample of equities (Moss, Lawson EY (DB 2765)). Each of these was tested currently, with a one-quarter lag; and as a four-quarter moving average, first with equal weights then with declining weights (t-1 = .30, t-2 = .35, t-3 = .25, t-4 = .10). In addition, I tried allowing the unemployment index to come in multiplicatively with a four-quarter seasonal; I tried using a price difference term, the first difference of the GNE deflator both current and lagged once; and I tried the cash flow ratio variable, which had been used successfully in other experiments, to see if I could measure the response of inventories to pressures on working capital. The last formulation consists of cash flow, which is the sum of corporate retained earnings (DB 1393) and corporate capital consumption allowances (DB 3711), fitted to a linear trend from 1950 to 1965 and then divided by the series of trend values.

Results from these experiments are comparatively meagre. The financial variables are all wrongly signed except for the equations noted in Table 6. In general the interest rate variables seem to conform more closely to theoretical expectation when the shorter period is used; this agrees with Courchene's results on manufacturing inventory for the period 1955 to 1962. But the interest rates also perform better in conjunction with the equity yield, which is probably bringing in an expectations effect. On the whole, the few equations with correct a priori signs do not inspire much confidence, and they improve the fit of the equation very little. The experiments with a price term and with a seasonally-spread UI_t term produce insignificant results and weaker equations.

Thus efforts to extend the basic model led to few conclusive results. There are several new equations that cannot be rejected on the ground of a wrong a priori sign or on the ground of the weakening of the basic equation. Not one of the six has any clear-cut superiority over the others; although the equations in-

TABLE 6

Testing Financial Variables with 'Purged' GNE and Unemployment Index

	Constant	Q1	Q2	Q3	Y_t^P	ΔY_t^P	UI_t	H_{t-1}	CFR	RTB 4Q	CFR 4Q	EY 4Q	SEE	$\overline{R}^2$	D/W
Basic 1952-65	185.84 (1.55)	143.91 (1.58)	250.96 (3.58)	38.13 (0.90)	.155 (2.60)	-.300 (4.50)	-211.46 (4.89)	-.092 (2.43)					79.6	.726	1.85
1952-65	-0.15 (0.00)	113.50 (1.22)	197.29 (2.48)	11.95 (0.26)	.114 (1.73)	-.297 (4.50)	-200.79 (4.61)	-.065 (1.53)	188.28 (1.38)				78.9	.732	1.95
1956-65	515.60 (2.98)	311.08 (2.53)	146.25 (1.62)	-38.83 (0.79)	.142 (2.12)	-.180 (2.18)	-258.57 (5.12)	-.107 (2.12)		-15.34 (0.72)			73.7	.802	1.71
1952-65	645.86 (1.48)	82.36 (0.81)	254.29 (3.41)	57.92 (1.30)	.154 (2.27)	-.313 (4.69)	-144.82 (2.58)	-.106 (1.91)		-10.09 (0.48)	55.33 (0.33)	-89.62 (1.83)	77.8	.739	1.98
1956-65	1,026.08 (2.23)	203.67 (1.51)	138.34 (1.37)	-14.00 (0.27)	.135 (1.67)	-.198 (2.41)	-142.87 (1.94)	-.108 (1.60)		-24.26 (1.09)	34.92 (0.18)	-127.56 (2.09)	70.9	.817	1.89
Basic 1956-65	546.63 (3.29)	342.47 (3.00)	160.45 (1.83)	-37.33 (0.77)	.158 (2.53)	-.179 (2.18)	-269.90 (2.91)	-.126 (5.67)					73.1	.805	1.70
Omitting 1Q56 1952-65	140.12 (1.26)	50.57 (0.57)	251.25 (3.91)	45.55 (1.16)	.133 (2.41)	-.331 (5.34)	-198.81 (4.98)	-.073 (2.06)					73.2	.744	1.93
Omitting 1Q56 1956-65	431.12 (2.46)	210.27 (1.56)	171.28 (2.01)	-22.18 (0.46)	.132 (2.12)	-.232 (2.71)	-255.33 (5.44)	-.097 (2.14)					71.0	.795	1.75

cluding financial variables imply such trivial impacts that they are perhaps better ignored on grounds of simplicity.

More information has now become available from that most reliable of sources, the passage of time. Since the equations in Table 6 were developed, observations for 1966 and the first quarter of 1967 have been generated to provide a check on the validity of the final equations. This testing was carried out in several ways. First, the equations fitted from 1952 to 1965 were projected forward for five quarters. Then they were refitted to the end of 1966 and their performance checked over the same five quarters. These equations are given in Table 7, and as can be seen the coefficients differ very little indicating a stable structure into 1966. Examination of the residuals suggested that a major movement in the first quarter of 1956 might be twisting the regression plane, so this quarter was dropped and the basic equations refitted over 1952-65, 1952-66, 1956-65, and 1956-66. In all cases the residuals, the sums of squared residuals for 1966 and 1Q67, and the absolute sums of residuals for these periods were calculated. The results are shown in Table 8. Finally a naive test was performed by projecting forward the quarterly means of inventory investment over the various time periods and calculating the same residual test statistics for them. The projection test is questionable on one count; in that, for simplicity, H_{t-1} is taken as the actual H_{t-1} in each projected quarter rather than what H_{t-1} would be if predicted inventory investment were being cumulated. This procedure simplifies computations greatly without having much impact on the actual result.

Comparison of equation performance shows that the equations fitted to the end of 1966, though little different in structure, are better 'predictors' for 1966 and 1Q67. This is hardly surprising. Perhaps more interesting is the fact that dropping 1Q56 from the calculations has so little effect. As can be seen from Tables 6 and 7, the 'gap' tends to draw the 1956 equation closer to the 1952 structure. But the 'predictive' capacity of the gap equation is generally weaker. On almost all parallel tests, as shown in Table 8, the gap equations are inferior. In no case are they significantly superior; consequently this approach does not seem worth pursuing. As for our other financial variables, their insignificance in the equations is confirmed in the prediction results. In the 1952-65 and 1952-66 equations these variables

TABLE 7

Equations in Table 6 Fitted to 1966

	Constant	Q1	Q2	Q3	Y^P_t	ΔY^P_t	UI_t	H_{t-1}	CFR	RTB 4Q	CFR 4Q	EY 4Q	SEE	$\bar{R}^2$	D/W
Basic 1952-66	170.83 (1.59)	175.37 (1.87)	247.11 (3.56)	27.66 (0.65)	.153 (2.64)	-.268 (4.03)	-206.05 (4.74)	-.090 (2.35)					82.7	.713	2.04
1952-66	0.06 (0.00)	143.18 (1.50)	185.23 (2.27)	-0.25 (0.01)	.104 (1.56)	-.260 (3.93)	-196.38 (4.51)	-.060 (1.37)	191.08 (1.42)				81.9	.718	2.13
1952-66	474.70 (1.31)	124.75 (1.22)	251.73 (3.40)	46.22 (1.06)	.148 (2.13)	-.276 (4.08)	-152.91 (2.83)	-.099 (1.81)		-6.24 (0.32)	105.59 (1.65)	-71.58 (0.67)	81.3	.723	2.16
Basic 1956-66	417.54 (2.83)	380.64 (3.10)	180.99 (1.99)	-36.65 (0.73)	.177 (2.73)	-.159 (1.85)	-249.84 (5.05)	-.128 (2.74)					79.5	.771	1.93
1956-66	82.97 (0.27)	303.95 (2.23)	58.21 (0.44)	-80.41 (1.32)	.078 (0.76)	-.136 (1.56)	-223.87 (4.21)	-.057 (0.77)	271.62 (1.26)				78.9	.774	2.05
1956-66	712.07 (1.85)	223.99 (1.59)	128.44 (1.25)	-24.07 (0.47)	.115 (1.33)	-.158 (1.81)	-131.17 (1.85)	-.083 (1.22)		-21.11 (0.97)	174.23 (0.95)	-121.51 (2.07)	77.0	.785	2.21
Omitting 1Q56 1952-66	128.49 (1.27)	82.53 (0.89)	247.86 (3.83)	34.72 (0.88)	.130 (2.39)	-.299 (4.77)	-194.76 (4.79)	-.071 (1.95)					77.1	.727	2.15
Omitting 1Q56 1956-66	329.53 (2.15)	243.79 (1.68)	188.17 (2.12)	-23.88 (0.48)	.146 (2.20)	-.211 (2.36)	-239.14 (4.92)	-.098 (1.99)					77.6	.761	2.02

bring about some slight improvements, but in the 1956 equations they do more harm than good. Moreover it appears that what little they do contribute comes in through the equity yield and the cash flow ratio rather than the treasury bill rate. Since the equity yield reflects stock prices and the cash flow is highly correlated with profits, the 1956 equations appear to be picking up a weak expectational factor rather than a cost-of-finance impact — therefore there seems to be no gain in maintaining these forms.

The best equation on the basis of Table 8 is clearly the basic model fitted from 1956 to 1966. This equation has the lowest sums of absolute and of squared residuals over all five quarters, and is superior by a substantial margin in most cases. That it should dominate those equations fitted only to the end of 1965 is not particularly surprising — one is surprised to find that it is also the best of the 1966 group. Of equations fitted to the end of 1965, the 1956-65 equation is clearly better than the 1952-65, and is even slightly better than the 1956-66 equation in 1967. However the difference is hardly large enough to outweigh the dominance of the 1956-66 equation in 1966. Thus our equation of choice is:

(1956-66)

$$\Delta H_t = \underset{(2.83)}{417.54} + \underset{(3.10)}{380.64}\, Q_1 + \underset{(1.99)}{180.99}\, Q_2 - \underset{(0.73)}{36.65}\, Q_3$$

$$+ \underset{(2.73)}{.177}\, Y_t^P - \underset{(1.85)}{.159}\, \Delta Y_t^P - \underset{(5.05)}{249.84}\, (UI)_t - \underset{(2.74)}{.128}\, H_{t-1} \qquad (2.8)$$

$$SEE = 79.5 \qquad \overline{R}^2 = .771 \qquad D/W = 1.93$$

Comparing this equation to the naive quarterly mean projections shows that it comes out a long way ahead in 1966 and trails in 1Q67 in all cases. 1Q67 was a bad quarter for all our equations. But its superiority in 1966 outweighs this disadvantage — over these five quarters the 1952-66 quarterly means do best with $\Sigma u^2 = 81,477$ $\Sigma|u| = 555$. As against this, our equation fitted 1956-66 gives $\Sigma u^2 = 71,965$ $\Sigma|u| = 442$ despite its relatively much weaker performance in 1Q67.

TABLE 8

Part 1

Prediction Capacity of Sample Equations

		Basic Equation 1952-65	Current CFR 1952-65	MOV.AVG. CFR,RTB,EY 1952-65	Basic Equation 1956-65	MOV.AVG. RTB 1956-65	MOV.AVG. CFR,RTB,EY 1956-65	Basic Equation 1952-66	Current CFR 1952-66	MOV.AVG. CFR,RTB,EY 1952-66	Basic Equation 1956-66	Current CFR 1956-66	MOV.AVG. CFR,RTB,EY 1956-66
Predicted Value													
1966	1	494	515	498	444	448	443	478	491	464	457	477	446
	2	69	91	61	15	20	28	89	104	85	69	94	79
	3	46	45	38	-38	-30	-27	47	42	49	0	10	33
	4	149	180	117	95	107	85	149	170	129	129	171	124
1967	1	451	468	431	342	344	355	437	441	427	359	387	383
Residual													
1966	1	-114	-135	-118	-64	-68	-63	-98	-111	-84	-77	-97	-66
	2	-203	181	211	257	252	244	183	168	187	203	176	193
	3	-50	-49	-42	34	26	23	-51	-46	-53	-4	-14	-37
	4	-20	-51	12	34	22	44	-20	-41	0	0	-42	5
1967	1	-250	-267	-230	-141	-143	-154	-236	-240	-226	-158	-186	-182
Σu^2	66	57,105	55,988	60,353	72,457	69,288	65,970	46,094	44,030	44,834	47,001	43,053	42,999
u^2	67	62,500	71,289	52,900	19,881	20,449	23,716	55,696	57,600	51,076	24,964	34,596	33,124
$\Sigma \lvert u \rvert$	66	367	416	383	389	368	374	352	366	324	284	329	301
$\lvert u \rvert$	67	250	267	230	141	143	154	236	240	226	158	186	182

TABLE 8

Prediction Capacity of Sample Equations

		Basic 1Q56OUT 1952-65	Basic 1Q56OUT 1956-65	Basic 1Q56OUT 1952-66	Basic 1Q56OUT 1956-66	Quarterly Means 1952-65	Quarterly Means 1952-65	Quarterly Means 1952-66	Quarterly Means 1952-66
Predicted Value									
1966	1	483	448	471	457	258	314	266	318
	2	63	21	86	72	15	-8	32	11
	3	49	-17	53	14	13	7	12	6
	4	152	114	154	143	43	86	49	89
1967	1	458	373	439	383	258	314	266	318
Residual									
1966	1	-103	-68	-91	-77	122	66	114	62
	2	209	251	186	200	257	280	240	261
	3	-53	13	-57	-18	-17	-11	-16	-10
	4	-23	15	-25	-14	86	43	80	40
1967	1	-257	-172	-238	-182	-57	-113	-65	-117
Σu^2	66	56,628	68,519	46,751	46,449	88,618	84,683	77,252	73,665
u^2	67	66,049	29,584	56,644	33,124	3,249	12,656	4,225	13,689
$\Sigma \lvert u \rvert$	66	388	347	359	309	482	400	490	373
$\lvert u \rvert$	67	257	172	238	182	57	113	65	117

Returning from the empirical results to the theory on which the experiments were based, (2.8) may be interpreted in the light of the model (2.7). Then $\rho = .159/.177 = .898$. This implies $S_t^e = .102\ S_t + .898\ S_{t-1}$ or relatively weak forecasting by inventory-holders. According to the model only 10 per cent of sales change is forecast, an implausibly low result much below that of Lovell for the U.S. [16] pp. 542-550. 'Rational' business forecasting as defined by Bossons and Modigliani [2] implies a $(1 - \rho)$ of less than one if fully rational forecasts have an expected value of zero for the difference between forecast and actual, or $E(u_t) = 0$ where $S_t^e - S_t = u_t$. Similarly Theil finds that the conditions under which $(1 - \rho) < 1$ are quite broad [22] pp. 154-161. But a forecast of only 10 per cent of sales change is implausibly low.

On the other hand, if (2.8) is regarded as fitting the model of (1.7') with a passive inventory term, equivalent to (1.7") with $c = 1$, then the estimate of ρ drops to .135, implying relatively good business forecasting or $S_t^e = .865\ S_t + .135\ S_{t-1}$. This makes the passive or production inflexibility model more plausible. In general, for (1.7"), $\rho = (.159)/(c + .177)$ where $0 \leq c \leq 1$ and the larger is c, the better is business forecasting implied to be by the equation.

The other parameters of the model are b, the reaction coefficient, and d, the marginal stock/sales ratio. b is rather low, implying a long adjustment period,[7] while the marginal stock/sales ratio is 1.38. This is rather high, but below the average stock/sales ratio of about 1.6. It is worth noting that the flow variable approximating sales, Y^P, is flow per quarter; this explains the size of the stock/sales ratio. The low value of b is disturbing, given that inventory is believed to be rapidly adjustable by the holder. Perhaps the very large and apparently random error in inventory movements (reflected in the Coefficient of Variation of 73.5 per cent and the Durbin/Watson statistic of 1.93 in the final equation) leads to great caution on the part of inventory-holders in accepting and moving toward equilibrium levels. The fact that inventories are volatile need not imply that they are easy to adjust swiftly; large random movements may make the adjustment process a slow and cautious one.

[7] If $b = .128$, and H^* is constant, 42.2% of any gap is closed in four quarters.

Perhaps the most disappointing feature of this equation from the point of view of a policy-oriented model is the consistent failure of all financial variables to yield any measurable impact on inventory investment that could be justified in theory. Despite the range of variables tested and introduced with a variety of lag patterns and index forms (from the treasury bill rate to the over ten-year government bond yield and the industrial bond yield, including credit availability and price variables) the most assiduous data mining yielded only the rocks presented in Tables 6 and 7. Tests of predictive capacity soon reduced these to powder. Financial variables may have the hypothesized impact on inventory investment, but if so it does not show up in any form I have yet tested.

There is, however, another possibility. The whole purpose of building a simultaneous model is to derive consistent estimates of the individual equation parameters by using estimation techniques which avoid simultaneous equations bias. The inventory equation might be expected to be particularly subject to this form of bias since multiplier effects can be expected to lead from inventory behaviour to the activity variables which are treated as independent in the Ordinary Least Squares (OLS) estimation. In fitting the simultaneous model, (2.8) was reestimated using a type of two-stage least squares procedure in which a subset of the exogenous variables is chosen as instruments according to a causal ordering hierarchy developed by F. Fisher. The procedure (called Structurally Ordered Instrumental Variables, or SOIV) is discussed in the overall RDX1 model paper. Estimating the equation in the form yields:

1Q56 - 4Q65 (SOIV)

$$\Delta H_t = \underset{(3.83)}{603.846}\, Q_1 + \underset{(3.37)}{518.098}\, Q_2 + \underset{(0.46)}{53.381}\, Q_3 - \underset{(1.46)}{86.778}\, Q_4$$

$$+ \underset{([illegible])}{.135}\, Y^P_t - \underset{([illegible])}{.030}\, \Delta Y^P_t - \underset{([illegible])}{260.046}\, UI_t - \underset{([illegible])}{.120}\, H_{t-1} \qquad (2.9)$$

SEE = 76.7 $\quad \bar{R}^2$ = .786 $\quad$ D/W = 2.01

The same equation estimated by OLS yields:

1Q56 - 4Q65 (OLS)

$$\Delta H_t = \underset{(3.81)}{627.323}\ Q_1 + \underset{(2.83)}{326.314}\ Q_2 + \underset{(1.92)}{160.728}\ Q_3 - \underset{(0.85)}{39.285}\ Q_4$$

$$+ \underset{(2.66)}{.160}\ Y_t^P - \underset{(2.26)}{.190}\ \Delta Y_t^P - \underset{(5.74)}{271.921}\ UI_t - \underset{(3.03)}{.135}\ H_{t-1} \qquad (2.10)$$

SEE = 72.4 $\bar{R}^2 = .809$ D/W = 1.70

(The OLS equation differs slightly from that reported in Table 6 due to minor changes in the input data made for consistency with the simultaneous model.) Fitted by OLS, the 1956-1965 equation looks quite similar to the 1956-1966 equation. This implies $\rho = 1.188$ if $c = 0$, suggesting that some degree of production inflexibility must be present. Also d and b are little changed. The significant feature, however, is that in the SOIV results, the ΔY_t^P variable loses almost all significance. Its coefficient implies a value of $\rho = .222$, or business forecasting of 77.8 per cent of quarter by quarter change. The result would be very interesting, except that ρ is not significantly different from zero (t = .22). This could imply very high accuracy in business sales forecasts; it could also cast some doubt on the model structure. Efforts to model the formation of sales expectations may simply be inadequate, and this inadequacy may be masked by simultaneous equations bias in the OLS estimates.

The SOIV results do, however, provide strong confirmation for the financial variables findings. After fitting (2.9) a range of cost-of-capital variables was retested to see if the SOIV form might enhance their role. I used the 90-day finance company paper rate RCP (DB 1129), the average rate on Government of Canada bonds due in less than three years R03 (DB 1365), and the rate on Government of Canada bonds due or callable in ten years or more RLC (DB 2764) both current and lagged one quarter. In addition the same variables were used in the index form current and lagged. Some of the results are presented in Table 9 where the SOIV results confirm the OLS. Whatever the theoretical model implied by

TABLE 9

Final Equation Form Tested with Assorted Financial Variables, Single and Simultaneous Equation Estimates

(All equations include the eight variables of the chosen equation plus, in most cases, an interest rate variable.)

Financial Variable*	Coefficient on Financial Variable	t Value of Coefficient	Estimation Method	SEE	$\bar{R}^2$
NONE			OLS	72.4	.809
NONE			SOIV	76.6	.786
RCP	9.47	.65	OLS	73.0	.809
RCPR	.006	.00	OLS	73.5	.803
R03	13.08	.69	OLS	73.0	.806
R03R	-1.61	.11	OLS	73.5	.803
RLC	52.63	1.47	OLS	71.1	.815
RLCR	-1.33	.09	OLS	73.5	.803
RCP_{-1}	1.24	.09	OLS	73.5	.803
$RCPR_{-1}$	-7.52	.65	OLS	73.0	.805
$R03_{-1}$	.04	.00	OLS	73.6	.803
$R03R_{-1}$	-12.02	.87	OLS	72.7	.807
RLC_{-1}	33.99	.85	OLS	72.7	.807
$RLCR_{-1}$	-12.17	.72	OLS	72.9	.806
$RCPI_{-1}$	25.27	.49	OLS	73.2	.804
$RCPIR_{-1}$	-.01	.00	OLS	73.6	.803
$R03I_{-1}$	39.03	.62	OLS	73.1	.805
$R03IR_{-1}$	.038	.24	OLS	73.5	.803
$RLCI_{-1}$	-87.22	.44	OLS	73.3	.804
$RLCIR_{-1}$	.93	.33	OLS	73.4	.803
RCP	10.99	.66	SOIV	78.6	.774
RCPR	21.83	1.03	SOIV	81.8	.756
R03	15.11	.71	SOIV	78.4	.775
R03R	-1.50	.08	SOIV	77.9	.779
RLC	62.23	1.48	SOIV	76.8	.784
RLCR	7.04	.36	SOIV	77.9	.779
RCP_{-1}	-4.17	.26	SOIV	77.4	.781
$R03_{-1}$	-2.75	.12	SOIV	77.7	.779
$RCPI_{-1}$	22.60	.39	SOIV	77.0	.783
$R03I_{-1}$	.67	.00	SOIV	77.8	.778

* R03, RLC, R03I and RLCI are as used previously. RCP is the rate on 90 day prime finance paper (DB 1129). RCPI is the same in index form. The real interest rates R03R, RLCR, etc. are defined as:

$$RLCR = RLC - 100 \left[\frac{PGNE - PGNE_{t-4}}{PGNE_{t-4}}\right]$$

where pgne (DB 9153) is the implicit private GNE deflator used in the aggregate model RDX1.

the results may be, it seems fairly conclusive that no role is left for cost-of-capital variables. Table 9 also shows the results of using real rather than money rates of interest as financial variables. In almost all instances, the adjustment of interest rates for expected price changes (using the price change over the preceding four quarters as a proxy for expected price changes) improves the performance of the financial variables. However, it remains the case that none of them enter significantly, with the right sign, into either the OLS or the SOIV parameter estimates. A radically different structural specification might show some impact of financial variables, but in the various specifications tested in this study I was unsuccessful in isolating a significant influence of interest rates on inventory investment.

Postscript:

The conclusions stated above cannot be asserted too confidently since evidence has recently become available that casts suspicion on the whole structure of the aggregate flexible accelerator inventory model. This is an inevitable risk when a dynamic specification process is combined with long production lags. The basic work of this study was done in the summer of 1966 and the simultaneous model RDX1, in which the inventory equation belongs, has been developed considerably since then. In particular, a revision of the structurally ordered instrumental variables technique which changes the 'instrument package' by reducing the number of quasi trends, leads to an estimate of our basic model as follows:

1Q56 - 4Q65 (SOIV-B)

$$\begin{aligned} \Delta H_t = \underset{(5.68)}{610.6} + \underset{(3.05)}{366.8}\, Q_1 + \underset{(0.55)}{58.80}\, Q_2 - \underset{(1.54)}{83.63}\, Q_3 - \underset{(1.63)}{0.0830}\, H_{t-1} \\ + \underset{(1.21)}{0.0855}\, Y_t^P - \underset{(0.95)}{0.1020}\, \Delta Y_t^P - \underset{(5.64)}{287.9}\, UI_t \qquad (2.11) \end{aligned}$$

SEE = 74.62 $\qquad \overline{R}^2 = 0.797 \qquad$ D/W = 1.80

The extreme weakness of the coefficients on Y^P and ΔY^P, and the implausibly small value of b make it very difficult to interpret these coefficients as representing the structural parameters of the flexible accelerator model. No effort was made to refit equation (2.11) with financial or other cost variables, since their weakness in earlier experiments did not seem to be due to any relationship with the activity variables. When we compare (2.11) with (2.9) and (2.10), it appears that 1966 equations do not fit well into a 1969 model — thus the need for further research is amply demonstrated.

VARIABLES

DB — Numbers in brackets with the prefix DB refer to the index numbers of these series on the Databank Master Tape at the Bank of Canada. A master tape containing all series referred to in the Bank of Canada Staff Research Studies is available to the public.

Dependent Variable

ΔH_t — Change in Canadian non-farm inventories in 1957 dollars, not seasonally adjusted, in quarter t (DB 150).

Activity Variables

All are in 1957 dollars, not seasonally adjusted, unless otherwise specified.

H_t — Canadian non-farm inventory stock (DB 11636) at the end of period t, constructed by cumulating ΔH_t from the *National Accounts Income and Expenditure* (issued quarterly and annually by the Dominion Bureau of Statistics) on a base value of $5,185 million in 4Q46.

H_t^* — Equilibrium or desired level of non-farm inventories in period t (unobservable) defined as a function of sales, cost, and expectations variables to be determined in the study.

Y_t — Quarterly Gross National Expenditure (DB 157) used as a proxy for sales (S_t) hypothesized to influence expected sales (S_t^e), desired inventories, and actual inventories.

Y_t^* — The estimated value of Y_t found by fitting Y_t to a time trend quarterly from 1947 to 1965 in the form

$\log Y_t^* = a_0 + a_1 t.$

Y_t^P A 'purged' sales variable differing from Y_t in being built up from those components of Gross National Expenditure believed to be most closely related to sales of goods. Y_t^P is the sum of consumer durable and non-durable goods expenditures (DB 141, DB 140), business gross fixed capital formation (DB 144), total government non-wage expenditure on national accounts basis (DB 2171, DB 4079, DB 4104) and exports less imports (DB 153, DB 154).

Expectational Variables

$STOCK_t$ The difference between the Toronto Stock Exchange index of common stocks (DB 2597) and its log trend fitted from 1946 to 1965 in the form log stock index = $a_0 + a_1 t$.

EQR_t The ratio of the Toronto Stock Exchange index to its trend value, the same variables whose difference yields $STOCK_t$.

(APP/VAC) The ratio of unplaced applicants for employment (DB 3979) to reported unfilled job vacancies (DB 3965) across all industry divisions.

U_t The quarterly average unemployment level (DB 1202, DB 1203).

ΔU_t $(U_t - U_{t-1})$

UI_t $12\, U_t / \sum_{i=1}^{12} U_{t-i}$

Financial Variables

r Any general measure of the cost of finance.

RTB The average interest rate in quarter t on Canadian treasury bills of three months to maturity (DB 601).

R03 Average interest rate on Government of Canada bonds

maturing in less than three years (DB 1365).

RLC — Average interest rate on Government of Canada bonds due or callable in ten years or more (DB 2764).

i — Any general financial variable in index form,

$$i_t = (\sum_{j=1}^{12} r_{t-j})/12\ r_t$$

$(L/A)_t$ — The ratio of total business loans outstanding (DB 687) to the level of loan authorizations provided by the banking system (DB 608) both in quarter t.

IBY — (Not reported in tables) The yield on a sample of industrial bonds prepared by McLeod, Young, Weir (DB 268).

EY — The yield on a sample of selected equities prepared by Moss, Lawson (DB 2765).

CFR_t — The cash flow ratio, calculated by summing corporate retained earnings (DB 1393) and corporate capital consumption allowances (DB 3711) and fitting these to a linear trend from 1950 to 1965. CFR_t is then the ratio of actual to fitted trend value both in quarter t.

CFR 4Q — A four-quarter moving average of the variable with weights t-1 = .30, t-2 = .35, t-3 = .25, t-4 = .10.

RCP — The average interest rate on 90-day finance company paper (DB 1129).

RCPR, RLCR, etc. — Real interest rates, found by subtracting the rate of change of the implicit private GNE deflator from the nominal interest rate, e.g.

$$RLCR_t = RLC_t - 100\left[\frac{PGNE_t - PGNE_{t-4}}{PGNE_{t-4}}\right]$$

RCPI, RLCI, etc. — Interest rates in the index form defined above for i_t. Note that they should have positive signs a priori.

Parameters

b The speed of adjustment in the flexible accelerator,

$$\Delta H_t = b(H_t^* - H_{t-1}) + \text{other variables.}$$

d The marginal quarterly stock/sales ratio; if expected quarterly sales increase by 1, desired inventory stock increases by d.

ρ, λ Parameters associated with alternative mechanisms of sales expectations formation. If expectations for period t are formed by forecasting the change ΔS_t and adding this to the level of last period, then

$$S_t^e = S_{t-1} + (1 - \rho)\ \Delta S_t = (1 - \rho)\ S_t + \rho S_{t-1}.$$

If expectations are formed from a moving average of past values with geometrically declining weights, then

$$S_t^e = (1 - \lambda)\ [S_t + \lambda S_{t-1} + , \ldots , \lambda^n S_{t-n}]$$

In equation forms (1.8') and (1.7") only

c A production inflexibility or passive accumulation term which represents the proportion of the error in sales forecast ($S_t^e - S_t$) which is added to or subtracted from inventories e.g. if c = 1.0, then production is not adjusted at all in period t to allow for errors in sales forecast and the whole forecast error is reflected in inventory change. (c is also used as a general constant in other equation forms, with and without subscript.)

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No. 3

BANK OF CANADA
STAFF RESEARCH STUDIES

THE STRUCTURE OF RDX1

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LAWRENCE H. OFFICER

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IAN A. STEWART

1969

ISSUED BY THE PUBLICATIONS COMMITTEE OF THE BANK OF CANADA

THE STRUCTURE OF RDX1

John F. Helliwell

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Ian A. Stewart

This study was prepared as part of the econometric research program of the Research Department of the Bank of Canada. The views expressed are the personal views of the authors and no responsibility for them should be attributed to the Bank.

Revised to July 15, 1969.

PREFACE

The RDX1 Model (Research Department "Xperimental" Model — version 1) is a preliminary result of a larger econometric research program sponsored by the Research Department of the Bank of Canada. This program also involves detailed partial studies of various sectors of the Canadian economy, several of which have provided equations used in RDX1.

This paper is a progress report on the structure of RDX1 as it stands at present. It goes without saying that much further work remains to be done in improving the design of the model before any great confidence can be placed in the answers it gives to practical questions concerning economic behaviour and policy. Even at this early stage in the model's evolution, however, it may be of interest to report on the general structure and dynamic properties as these have emerged so far. This paper is, therefore, a description of the general structure of RDX1. A report on its dynamic properties as revealed by a series of simulation experiments, will appear in a succeeding paper.

The RDX1 model has been under the principal direction of the authors. The results reported here, however, rest on the work of a larger group. The following people devoted varying but substantial proportions of their time to RDX1 over the construction period: Robert Evans, Fred Gorbet, Claude Huot, Jules Hurtubise, Peter Miles, Diane Nymark, Lynne Orman, Lawrence Smith, and Donald Stephenson. Several other colleagues have also made valuable contributions during many discussions and seminars in the Research Department.

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CHARTS

THE STRUCTURE OF RDX1

1. Introduction

RDX1 is an intermediate-sized aggregate quarterly model of the Canadian economy. It has 101 equations, including 50 stochastic behavioural equations and 51 technical relationships and identities. Since the ultimate object of its design is to improve our understanding of the consequences of monetary and fiscal policy actions, we tried to incorporate explicitly instruments of economic policy, such as tax rates and bank reserves. Particular attention has been paid to the financial and government sectors, where policy instruments have their direct and immediate impact on variables that affect, directly or indirectly, various components of aggregate demand or supply, or both.

In its basic format the model is designed along the lines of existing macroeconomic models depicting the economy as a dynamic process involving the successive generation of income, aggregate demand, output, wages and prices. The model does, however, try to capture certain distinctive features of the Canadian economy. The most striking and important of these characteristics is the extreme sensitivity of the Canadian economy to economic influences generated in other countries, particularly the United States. This openness involves both the real and financial sides of the economy. Thus foreign output, prices, and interest rates enter as important variables in several sectors of the model. As one would expect, this openness has a marked impact (through various leakages) on the nature of the feasible economic targets of Canadian economic policy. The structure of the model centers around the determination (given the constraints implied by foreign economic influences) of real gross private expenditure, real private output, and of employment along with the associated prices. Since the entire government sector (as well as farm inventory investment) is treated in current dollars, our key price variable (PGNE) is the implicit price index for real private sector expenditures (YGPK). The key features of the model are portrayed in Chart 1.

Our strategy and approach in constructing this model are

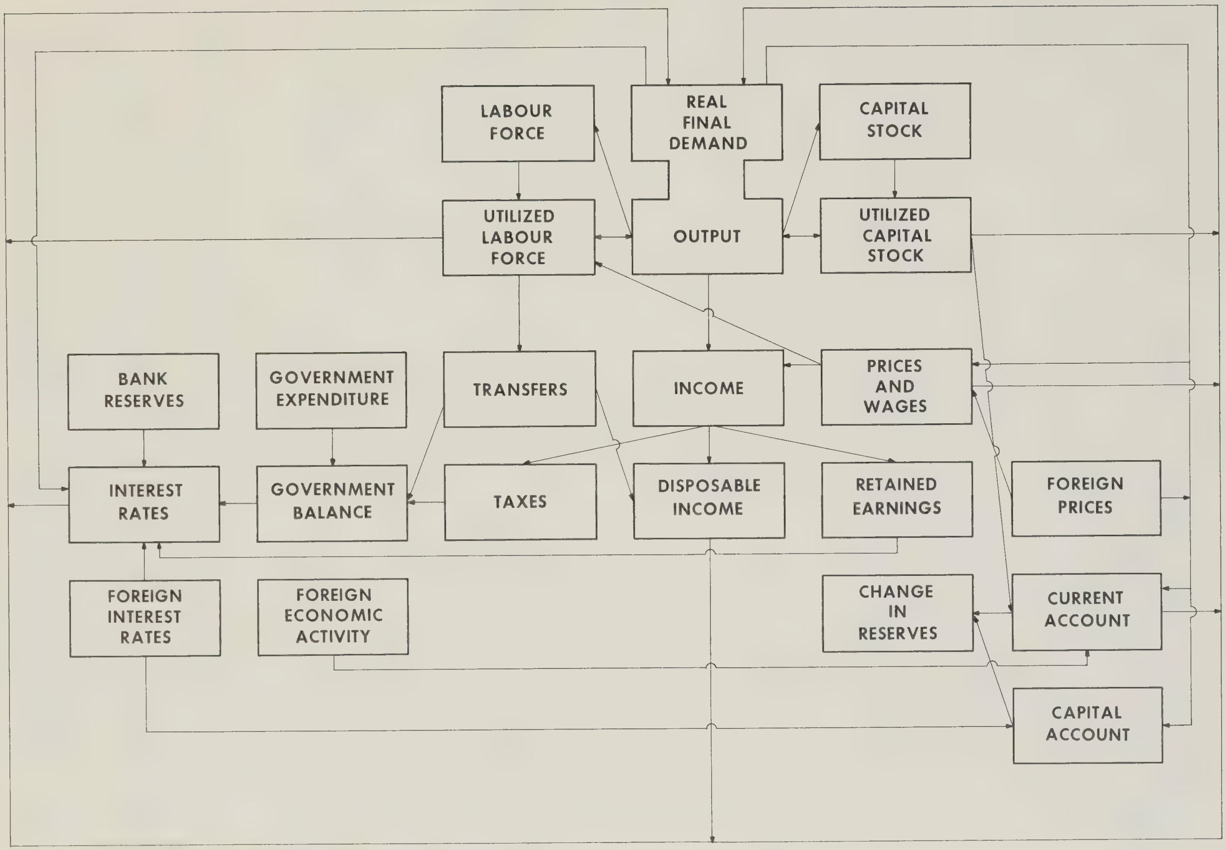
somewhat different from those of previous builders of large aggregative models. Rather than aim at 'perfection' in the specification of each individual relationship, by extensively testing in isolation the validity of different theories of consumption, investment, wage determination, etc., we decided to concentrate on the analysis of the dynamic properties of a complete system, although its initial specification was not really satisfactory in some cases. We believed that an early examination of the interactions and feed-backs of the various sectors of the model would yield the most valuable insights regarding future improvements in its specification and would clearly indicate, before all resources and energy were spent, which sectors (or which parameters) required special attention. What we are presenting here is the set of structural equations that we have chosen to call RDX1. Some of these equations were selected prior to any dynamic experiments with a complete model, while others reflect alterations suggested by the results of our first round of simulation tests.

RDX1 is a quarterly model whose parameters were estimated from data generated over the period 1952-1965. Due to data limitations, the parameters of certain relationships were estimated on the basis of shorter sample periods, but no period was less than 36 quarters. The data generated by the economy in 1966 and 1967 were reserved to test the predictive power of the individual equations and of the entire system. Data not adjusted for seasonality were used throughout and seasonal adjustments made by constructing independent variables incorporating the degree of seasonality appropriate for each equation. The quarterly data themselves are of rather uneven quality. While the trade statistics are very good, investment figures involve the use of activity measures to make quarterly allocation of annual surveys of equipment put in place. The financial data are fairly satisfactory apart from the absence of sectoral balance sheet and certain deposit and loan rate series. Our specification is also constrained by the lack of a quarterly breakdown of consumer durable expenditure into its major components. Important work remains to be done to improve the data base for a model of this nature. The forthcoming decennial revisions of the *National Accounts* [1] may materially change the data on which RDX1 is based.

Our preliminary parameter estimates were derived by ordinary least squares (O.L.S.), although where simultaneity seemed espe-

Chart 1

A SIMPLIFIED VERSION OF RDX1



cially severe (as in the case of consumer expenditure), several individual experiments with instrumental variables were carried out. Furthermore, where first-order serial correlation was deemed to be serious, we transformed all the variables by an appropriate Markov process and reestimated the equation. Finally, however, to obtain a set of consistent estimates, the entire model (other than three equations employing a first-order Markov process) was re-estimated using a two-stage procedure developed by F.M. Fisher. (See [5] and [8].) Denoted in this paper as T.S.F. (Two-Stage Fisher) or S.O.I.V. (Structurally Ordered Instrumental Variables), this method attempts to utilize the causal structure of the model as a guide to the selection of predetermined variables to be used in the first stage of a two-stage method of estimation. Some selection procedure is, of course, necessary whenever the number of predetermined variables in a model is large in relation to the number of available observations on the jointly determined variables. Briefly, for each endogenous variable used as an independent variable in a stochastic equation, the largest invertible matrix of a causally-ordered set of predetermined variables is found, and predetermined variables in ascending order from lowest to highest rank are tested for positive contributions to adjusted R^2 (denoted by $\overline{R}^2$) in order to select a final set of variables. A final regression is performed upon the set of predetermined variables thus selected, and the calculated values from these regressions are used as instruments for current endogenous explanatory variables in the estimation of the parameters of the structural equations by the method of instrumental variables. Unfortunately, this method is somewhat arbitrary in practice, and we are engaged in writing a computer routine that embraces a more flexible set of rules for the selection of first-stage instruments. We hope to examine the properties of various selection procedures and make available both this program and the existing program for the execution of the Fisher procedure.

Finally, we are concerned with presenting model-documentation in a form that will permit replication, critical examination, testing, or other use of the model. Our concern has led us to design a system that permits the release of the model, its supporting programs (including estimation procedures and simulator) and data, all combined in a machine-readable and manageable package. This package, which is described in a forthcoming manual [10], is built around the facilities offered by *Program Simulate II*

[7] and modifications that we have made in the program. These modifications permit magnetic tape storage of both model and data, enlarge the capacity of the simulator itself, and ease the problems of variable, equation and data changes in model experimentation.[1]

In Section 2 we present a description of the structure of the model.

There are three appendices to this paper. The sectors of the model in the order in which they are discussed in the paper are listed in Appendix A. Under each sector heading are listed the stochastic equations, technical relationships, and identities contained within the indicated sector. Appendix B is an alphabetical list of the estimated stochastic equations (showing both O.L.S. and T.S.F. estimates) and the identities. Appendix C is an alphabetical list of the endogenous and exogenous variables in the system and includes the reference numbers of these series on the Research Department's Databank tape.

2. Specification of the Model

A. Private Aggregate Demand

<u>1. Consumer Expenditure</u> - The present model distinguishes three components of consumer expenditure: durables, non-durables, and services.[2] Two simple relationships connect expenditures on non-durables and services to their determinants. Expenditures on non-durables are related to permanent disposable income (a weighted average of past values of disposable income), transitory income (current disposable income minus permanent income) and relative prices (equation 7), while expenditures on services are specified as a function of permanent income only (equation 8).

[1]After experimenting with a number of solution methods, we have found the Gauss-Seidel procedure to be generally faster than any of the alternatives. Each quarter's solution of RDX1 on the Univac 1108 requires approximately 2 seconds.

[2]Consumption of (as distinct from expenditure on) services includes a host of items (largely flowing from household stocks of durables) not reflected in the *National Accounts*. These omitted services are equivalent to the loss in value of the stock during the period plus the opportunity cost of the capital invested in the durables. We were unable to make sufficiently accurate estimates of these flows because of poor data on household stocks. Therefore we limit our analysis to fluctuations in the magnitudes reported in the *National Accounts*.

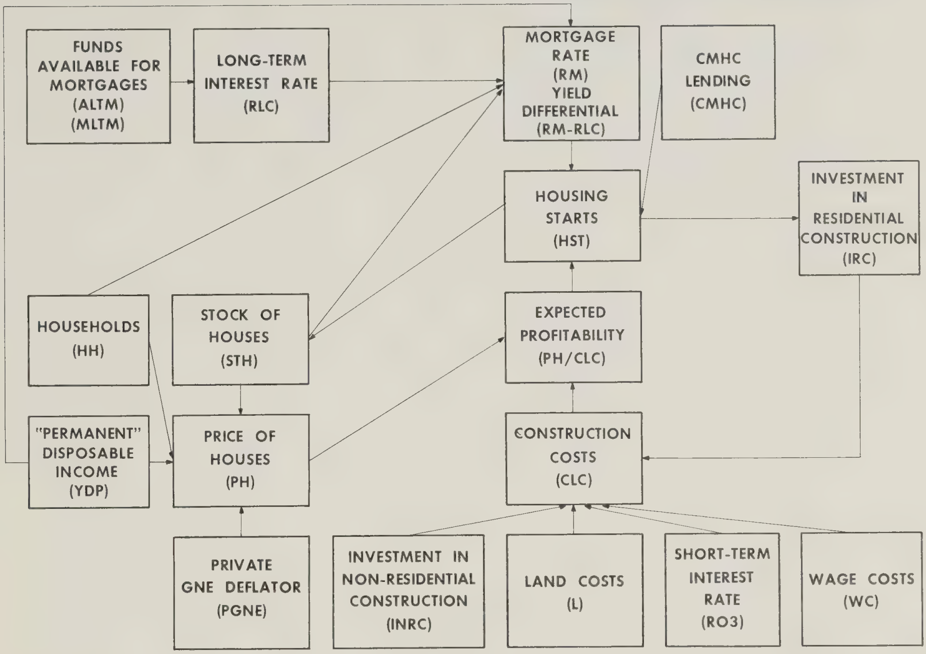
Expenditures on consumer durables are related to permanent income, transitory income, relative prices, and long-term interest rates (equation 2). Thus monetary (interest-rate) effects are transmitted directly to this component of aggregate demand. Interest rates enter this equation with a considerable lag (three quarters), reflecting the slow adjustment of consumer credit markets to changes in overall credit conditions. Although systematic tests are underway to try to determine the effects on consumer durable expenditures of additional variables related to consumer credit markets, the results of these experiments are preliminary and not reflected in this model. Government expenditure and taxation policies, of course, have a major influence on all types of consumer expenditure through their effects on disposable income. At this stage, however, our consumption functions do not isolate any separate expenditure effects of transfer income (such as unemployment insurance and old age pensions). Also missing from the current model is a mechanism that relates the prices of consumer goods and services to changes in sales and excise taxes.

2. Residential Construction - Our model of residential construction activity centers around the determination of three basic variables: the volume of housing starts, the ratio of housing prices to construction costs, and the interest rate on mortgages. Actual expenditure on residential construction is then related directly to current and past levels of housing starts (equation 26). The general structure of this sector is illustrated in Chart 2.

The volume of housing starts (HST) is determined by the expected profitability of building homes, measured by the ratio of housing prices to construction costs (PH/CLC), and the cost and availability of mortgage credit (equation 21). The cost of mortgage credit (RM) is measured as a simple average of the conventional mortgage rate (RC) and the rate on NHA (government-guaranteed) mortgages. On the other hand, the 'availability' of mortgage credit is represented by two distinct variables. The first is a flow variable (CMHC) representing the actual purchases of residential mortgages by the government housing agency, Central Mortgage and Housing Corporation, and the second is the yield spread (RM - RLC) between mortgages and long-term government bonds. This latter variable is meant to serve as a proxy for variations in the non-price terms of the mortgage contract. For any given

Chart 2

FLOW CHART OF HOUSING AND MORTGAGE MARKETS



yield on mortgages, the smaller this spread the less 'available' is mortgage finance in the model. The yield on conventional mortgages (RC) is determined by a 'reduced form' equation derived by solving the demand and supply equations for mortgages for the mortgage rate. The resulting relationship (equation 63) relates the yield on conventional mortgages to other factors governing the demand for mortgage finance (income (YDP), number of households (HH), stock of houses (STH), etc.) and the supply of mortgage finance, (assets of trust, mortgage, and life insurance companies (ALTM), long-term bond rates (RLC), etc.). The mechanism determining the price of houses (PH) is represented by a single relationship (equation 57), which regresses housing prices on variables representing the demand for housing (disposable permanent income (YDP), number of households (HH), etc.), the supply of housing (existing stock of houses (STH), etc.) and the general

price level (PGNE). In equation 61 building costs (CLC) are related to the wages of construction workers (WC), land prices (L), the cost of 'bridge' financing (R03), and the level of capacity utilization in the building industry as a whole. Our profits variable is then formed by taking the ratio of housing prices to construction costs. The variables representing the cost and availability of credit, along with construction costs and housing prices, then combine to determine, with various lags, the volume of housing starts and, with further lags, expenditure on residential construction.

In this model the influence of economic policy on residential housing works primarily through the financial side. First, there are the direct influences of economic policy on interest rates and on direct government lending. Second, there is the indirect influence of monetary policy, working through the asset growth (ALTM) of the primary suppliers of mortgage finance. The present model, however, takes the assets of these institutions (life insurance companies, trust and mortgage loan companies) as exogenous. (For further detail on the residential construction sector see [9].)

3. Business Investment - The two major components of business gross fixed capital expenditures, machinery and equipment (IME) and non-residential construction (INRC), are explained by equations 22 and 23 respectively. Net changes in business inventories (INV) are explained by equation 25.

Our capital expenditures equations are based on the capital-stock adjustment principle, with financial variables allowed the opportunity of influencing both the desired capital/output ratio and the time path over which the gap between actual and desired capital stock is removed. (For a full description of the capital expenditure equations see [4].) In the first phase of our research we dealt solely with gross investment equations whose primary purposes were to identify the lag structure on the accelerator variable and to isolate the correct depreciation rate used in constructing the capital stock series. At our first stage of experiments the estimated equations were of the form:

$$I_t^g = a + b \sum_{i=0}^{n} W_i (K^*_{t-i} - K_{t-i-1}) + cK_{t-1}$$

where I_t^g is quarterly gross investment, K_t^* is domestic non-farm output (Y) multiplied by a desired capital/output ratio, and K_{t-1} is the capital stock at the end of the preceding period. The longer-term desired capital/output ratio was obtained from a modified trend-through-troughs. The W_i weights are necessary because there are two kinds of lag between changes in output and the resultant induced changes in investment outlays. On the one hand, expectations of future output are likely to be based on a number of values of past output, and, on the other hand, there are lags between investment decisions and actual outlays. For each of the two types of capital stock, we chose the depreciation rate ρ whose resultant capital stock gave us an estimate of the replacement parameter c equal to the assumed ρ. This stage of experiments produced quarterly exponential-decay depreciation rates of one per cent for INRC and five per cent for IME. We found different seasonal patterns for both types of expenditures, and W_i distributions extending over eleven quarters for INRC and seven quarters for IME.

During our second stage of experiments we used net capital expenditures as our dependent variables, and tried to find appropriate roles for financial variables. If there are any cyclical changes in the desired degree of capital intensity, then we should bring the appropriate variables multiplicatively into our definition of K^*. Since the trend of the capital/output ratio has already been accounted for by our modified trend-through-troughs fitting, any corresponding trends in the financial variables must also be removed. In any event, we could scarcely hope (with only thirteen years of quarterly data) to disentangle the various longer-term changes in asset prices, yields, and technology responsible for any trend in the desired capital/output ratio. Most of our experiments, therefore, supposed that financial variables enter in one or both of the two following ways:

$$I_t^n = a + b \sum_{i=0}^{n} W_i (F_{t-i} K_{t-i}^* - K_{t-i-1})$$

$$I_t^n = a + b \sum_{i=0}^{n} W_i (K_{t-i}^* - K_{t-i-1}) + d \sum_{j=0}^{m} V_j F_{t-j}$$

where F is a financial variable expressed as a ratio to trend, I_t^n is net capital expenditures, and the V_j are weights, summing to one, which may or may not correspond to the W_i. The first specification shows F influencing the desired capital/output ratio, but not the timing of response. If F enters as in the second specification, or in both ways, then not only may the response lag differ for changes in F and output, but the time pattern of response of investment to changes in output may depend on the values of F. It was this sort of influence that we were anxious to make our equations able to capture.

In our final equations, chosen after a comprehensive range of experiments, the INRC equation has the ratio of cash flow to trend entering multiplicatively to influence K^*, and has the interest rate index entering as in the second specification above with the V_j equal to the W_i. The IME equation has the cash flow ratio entering as in the second specification; with $V_0 = 1$. Both equations fit well, and forecast within and beyond the sample period as well as alternative equations. The INRC equation is superior to the IME equation by all tests, and allows financial variables to enter in a more plausible way than does the IME equation.

The inventory-investment equation is based on a model [3] that assumes a constant marginal ratio of inventories to sales, supposes a lagged response of actual to desired inventories, and also allows inventories to play the role of a 'buffer stock'. Our O.L.S. parameter estimates imply relatively good sales forecasting, relatively slow adjustment, and a marginal stock/sales ratio of about 1.4, compared to the average stock/sales ratio of 1.6. In simultaneous estimation, however, the coefficients on sales, on the change in sales, and on the lagged stock, drop so low as to be not significantly different from zero. In neither O.L.S. nor in simultaneous equation estimation were we able to find any influence of financial variables, even though we ran experiments using a considerable number of alternative variables and specifications. We did, however, find a pronounced relationship between the rate of unemployment and inventory accumulation. The preferred specification of the variable, which we assume to be a proxy for changes in business confidence, is a ratio form, with the current number of unemployed divided by a moving average of the unemployed over the preceding twelve quarters.

4. Foreign Trade - Imports and exports of goods are determined both by demand conditions (activity variables and relative prices) and by the level of capital utilization in Canada. Imports (equation 40) depend first on domestic real expenditure. We define a variable (AM) as a weighted sum of the components of domestic expenditure, where the weights are based on input/output coefficients. The use of this activity variable permits differing marginal propensities for the various expenditure items.

$$
\begin{aligned}
AM = & .20\ (CD + CND) \\
& + .21\ (IME + INRC + IRC) \\
& + .11\ (XG) \\
& + .09\ (GNW/PGNE) \\
& + .17\ (INV)
\end{aligned}
$$

However, the influence of domestic real expenditure on imports is modified by the effect of capital utilization on the propensity to import. Capital utilization is measured as the ratio of real domestic non-farm product (Y) to its capacity level (YC). As capital utilization (Y/YC) increases, imports also increase, because there is less Canadian productive capacity available to satisfy the demand of any given level of expenditure.

The price variable in the import equation is the ratio of the price index of imports of goods (PMG) to the deflator of private (net of farm inventory investment) gross national expenditure (PGNE). The numerator (PMG) is the price index actually used to convert current-dollar to constant-dollar merchandise imports and the denominator (PGNE) is the principal price variable in the RDX1 system. Since PGNE represents the price of import-competing goods, the ratio itself is expected to have a negative effect on imports. Because the major part of Canadian imports comes from the United States, the activity variables are unlagged, reflecting the close economic relationships between the two countries (short distance, corporate links, etc.). On the other hand, one expects the price variable to have an effect that is distributed over time, because the price effect involves a decision to alter the relative importance of imports and home production as sources of supply distinct from increasing or decreasing imports in line with expenditure.

The activity variable explaining exports (equation 87) is a

weighted average of the indices of industrial production (or appropriate proxy series) in 75 countries (AWI). For a particular country the weight is proportional to the value of Canadian exports to that country in 1964 and 1965. The United States and United Kingdom have the largest weights (.55 and .14, respectively). The non-U.S. part of AWI is lagged one quarter, but U.S. activity enters currently once more reflecting the factors of distance and close economic links of Canada to the United States. As well, we also define a new capacity variable by removing exports of goods and services from the measure of actual output, i.e.:

$$\frac{Y - XG - XS/PXS}{YC}$$

The productive capacity for additional exports decreases as capacity utilization increases. Therefore we use the above measure as an explanatory variable, with an expected negative effect. The variable does not interact with the activity variable because the capacity measure involved is that for Canada, the supplier of the goods, as distinct from the demanders (the rest of the world). The price variable in the export equation is the ratio of the price index of exports of goods (PXG) to a price index of world exports (PWXG) with the latter expressed in Canadian currency for consistency with PXG. The price variable has the same interpretation here as in the import equation.

Unlike merchandise trade, we explain the service balance of payments item in current rather than constant dollars. While the price deflators for imports and exports of goods are reasonable and carefully constructed measures, those for services are understandably much less reliable. To explain imports of services net of dividend payments (equation 41), we use only an activity variable, namely, gross national expenditure (YGNE). The flow of services under consideration consists of many heterogeneous items — tourism, freight and shipping, interest, business services, etc. A price variable as in the merchandise equations makes little sense, given the nature of the components of services and the paucity of price data for flows that can be priced. We do not break down exports of services into dividend receipts and the rest of the flow. Instead we have just one relationship (equation 88), in which the activity variable (AWS) is a reweighted average of the foreign activity variable used in the equation for exports

of goods, with the weights now based on Canadian exports of services rather than of goods. We were able to achieve this reweighting for the United States, United Kingdom, and all other countries as a group. In the result the weight of the U.S. increases to .66, while that of the U.K. remains at .14.

B. Income Distribution, Employment and Prices

1. Employment and Hours - The Supply and Demand for Labour

We regard paid man-hours as the basic labour input to the aggregate production function, and we have separate, but interdependent, explanations for the level of private-sector employment and average weekly hours worked by each paid employed person. Since the labour market usually operates so as to leave a number of would-be workers involuntarily unemployed, we have separate supply and demand equations for workers, and we determine the number of unemployed as a residual. Average weekly hours, on the other hand, are explained by a single quasi-reduced-form equation whose structure suggests that short term changes in the number of hours worked per week are influenced mainly by demand considerations.

Changes in the aggregate labour force participation rate $(\frac{NL}{POP})$, according to our formulation (equation 45), are predominantly determined by the composition of the population and slowly changing attitudes towards work. The relevant effects of the changing composition of the population are captured by a variable measuring the proportion of the population going to school $(\frac{SP}{POP})$. Of the various trends operating on the participation rate, the positive trend induced by the increasing participation of women appears to dominate such negative influences as early retirements from the labour force; because the sum of our quarterly constant terms indicates an annual trend increase of over three per cent in the participation rate. The fairly weak cyclical variance in the aggregate labour force participation rate is captured by a variable measuring changes in constant-dollar per capita private expenditures, whose positive coefficient indicates that there is a net increase in labour force participation when aggregate demand increases.

The process governing changes in the demand for labour is rather more complex. An increase in the aggregate demand for the output of the private sector leads to increases in both the number of paid workers (NEPP) and average weekly hours (HAW), but the

dynamics of the response are quite different. The quarterly level of man-hours (= (NEPP)(HAW)(13)) adjusts with a slight lag to increases in output, but the response comes in the first instance mainly from increases in average hours. Thus, during the quarter in which demand increases, employment changes by less than its equilibrium response while average hours adjust by more than the final response, as the estimated parameters of their adjustment processes indicate.

The equilibrium level of paid private employment is determined (as shown in equation 43) by the level of output (YGPK + $\frac{GNW}{PGNE}$), and the trend value of average hours worked (HAWT). The deviation of current average hours worked from its trend value (HAWT - HAW) is also specified in this relationship. This variable measures the attempts of employers to restore average hours to their trend value. The parameter estimates reflect a less than complete substitution of men for hours. Thus any reduction in HAWT, for a given level of output, is accompanied by an overall reduction in the total number of man-hours worked.

Changes in average weekly hours (equation 17) depend upon differences between the current and the desired HAW, while the desired level of HAW depends on the level of output, the unemployment rate, the hourly wage rate (WPH), and a time trend reflecting the longer term reductions in the length of the working week. Low unemployment rates indicate a relative scarcity of workers, and lead to increases in HAW in order to obtain the necessary man-hours. Increases in the average hourly wage rate lead to reductions in HAW and, indirectly, in NEPP, presumably facilitated by the substitution of capital for labour.

The production function implied by the demand for labour equations suggests that marginal labour requirements are less than average requirements. For example, if aggregate demand increases by one per cent (of its mean value), the equilibrium increase in labour inputs in terms of man-hours is about 0.7 per cent, one-sixth of which is due to an increase in average weekly hours and the rest to an increase in the number of workers. This sort of labour requirement may be appropriate when there is a considerable amount of underemployment of paid workers, but is too optimistic for full employment extrapolation. As for changes in productivity, if output is held constant the labour require-

ment in terms of man-hours drops by about 0.2 per cent per year. This drop is comprised of a 0.9 per cent decrease in HAW, which is not quite offset by a 0.7 per cent increase in NEPP. The net decrease is closely matched by movements in the aggregate capital/output ratio, which rose during the data period by 0.2 per cent per year.

2. Wages - The wage-adjustment relationship (equation 85) is based on a number of hypotheses. First, the hourly money wage rate can be expected to respond to the level of excess demand in the labour markets (represented by the unemployment rate). The money-wage rate is expected to rise more with low unemployment rates than with high unemployment rates. In addition, the change in money wages will also be governed by recent increases in the price level as workers attempt to maintain their real incomes. Our coefficient on the price index of consumer non-durables (which we use as an approximation to the presumably more relevant Consumer Price Index) suggests that money-wage rates have almost unit elasticity with respect to price changes, and hence that wages respond fairly quickly and fully to changes in the price of non-durables. Finally, we introduce a variable representing the share of income allocated to profits to reflect the hypothesis that workers attempt to retain or increase their share of income. This variable may also reflect the willingness of firms to grant wage increases. The process by which wages adjust to changes in profits and unemployment rates is not assumed to be instantaneous; rather the effects of these variables are specified to filter into wages over a period of four quarters. As well, our estimated relationship shows the constraining effect of recent wage increases on further gains in money wages.

3. Prices - Our basic price variable (PGNE) is the implicit national accounts deflator linking current-dollar to constant-dollar gross private demand. Current-dollar private aggregate demand is, therefore, by definition equal to (PGNE)(YGPK). There are four main driving variables for PGNE (equation 56). They are total private wages (WP), total wages weighted by productivity changes (unit labour costs), the price of imported goods, and the difference between the actual and trend values of an inventory stock/sales ratio. Total wages enter in current form, while the other variables have polynomial lag distributions. The non-zero

values spread over 7 quarters (starting in t-2) for the price of imports, and over 5 quarters for unit labour costs (starting in t). The stock/sales variable has a polynomial lag distribution on a four-quarter moving average. The fact that private wages (WP) enter currently as well as in the unit labour-cost variable, in both cases with a positive coefficient, indicates that changes in the wage component of unit labour costs are more likely to have a direct influence on price formation than are changes in labour productivity. The moving average component of the unit labour cost variable represents an attempt to remove from private employment (NEPP) workers not engaged in producing the goods used to meet private sector demand (YGPK). The stock/sales ratio has the expected negative coefficient, indicating that greater sales have less effect on prices when inventory stocks are at high levels.

Despite our early resolve to limit drastically the separate price variables explained in RDX1, the appearance of important relative price effects in several equations forced us to explain some price indices in addition to PGNE. We also found that the price of consumer non-durables (PND) fitted much better than PGNE in the wage rate equation. Relative price-terms are particularly important in the equations for imports and exports of goods, consumer expenditures on durable and non-durable goods, and residential housing starts. The price of imports, given the exchange rate, may fairly safely be treated as exogenous, while the price of exports is more likely to be influenced by domestic prices. Our equation for the price of merchandise exports (equation 60) shows the implicit price index of goods exports (PXG) responding only partially to changes in PGNE (internal influences) and to the world price of exports (external influences). The world price index has an effect both because Canadian exporters may raise or lower their prices to meet foreign competition, and because of international commodity agreements. The price of exports-of-services (equation 61) responds partially to changes in PXG and more than 100 per cent to changes in PGNE. PXG enters as a second variable to represent the fact that the deflator of some components of current-dollar exports of services is actually the deflator for exports of goods. The price of consumer non-durables (PND) (equation 58) is a function of the same variables as PGNE, but shows half as great a response to wage changes, and twice as great a response to import prices. PND is not affected by the inventory stock/sales ratio. The price of consumer durables (PD)

proved impossible to explain accurately. Consumer durable expenditures are the only major element of the *National Accounts* whose detailed price indices are adjusted for quality improvement. As a result, the variable has no upward trend during the data period, and its considerable variance is not closely related to any of the variables directly affecting PGNE. Our equation shows changes in PD influenced only by quarterly dummy variables and changes in PGNE.

4. Corporate Profits and Dividends - Our original experiments with data generated over the period 1953-1965 produced a well-fitting corporate profits equation based on sales, the change in sales, the degree of capital utilization, the real hourly-wage rate, and changes in PGNE. The equation passed all the standard statistical tests, but failed to forecast profits accurately for 1966 and 1967. During those years there was a profits squeeze of a sort not experienced in the data period, so that the fitted equation overestimated profits throughout the forecast period. In this case we thought that the equation was important enough to justify further experiments in which forecasting performance would be used as a criterion in selecting a final specification. Even though the actual parameter estimates are still based only on the 1953-1965 data, this procedure has given us a profits equation for whose specification the 1966-1967 forecasting results do not provide a truly independent test. By introducing a four-quarter moving average of non-farm output per private employed worker (Y/NEPP), we found only sales and hourly money wages needed to be retained in order to produce an equation that fits the 1953-1965 data as well as the previous equation, and provides good forecasts outside the estimation period. Apparently the proximate cause of the 1966-1967 profits squeeze was a decline in productivity per employed worker. In view of the untypically low levels of unemployment and high rates of labour force growth at that time, the result seems very plausible. On the other hand, forthcoming revisions in the *National Accounts* series for corporate profits may show much of the 'profits squeeze' in 1966 and 1967 to have been a statistical artifact.

RDX1 has two equations (10 and 11) explaining dividends paid by Canadian corporations to residents and non-residents, respectively. The principal explanatory variable for each of these equations is the corporate cash flow, defined as the sum of cor-

porate profits and capital cost allowances less income tax accruals. Instead of taking current cash flow alone, we use a distributed lag over four quarters and an additional explanatory variable for dividend payments abroad. This is a dichotomous variable to represent increased taxation of dividends paid by foreign-owned or controlled subsidiaries in Canada to parent companies abroad.

RDX1 does not have stochastic equations to explain all income flows. We do explain the private component of wages, salaries, and supplementary labour income (see equation 86), indirect taxes, and corporate profits. The remaining components of national income, with the exception of dividend payments, are exogenous to the present model.

C. The Government Sector

In the government sector both expenditures and revenues are treated solely in current-dollar terms because taxes and transfers are defined in current dollars rather than constant dollars, and government expenditure decisions appear to be at least as easily described in money as in real terms. In any event, all government expenditures are treated as exogenous policy variables in RDX1. Although we have constructed models of all the major federal, provincial and municipal revenues and transfer payments [6], we decided to limit the scale of the government sector of RDX1 by including as endogenous variables only the revenues and transfer payments that either depend in an important way on other endogenous variables of the model or contain policy parameters that have been used or could be used by the federal government. Thus we include explicitly equations for the major federal tax revenues and for unemployment insurance fund income and revenue. Most of the other federal revenues and transfer payments may be treated safely as exogenous to RDX1, since our equations for them depend mainly on other predetermined variables and therefore may be used for forecasting outside the simultaneous model. These equations have been omitted primarily to ease the task of identifying the dynamic structure of RDX1, which contains 24 equations for government revenues and transfer payments. The personal income tax model has 12 equations, the unemployment insurance fund has 5, and there are 7 other tax equations.

In addition to the personal tax model, we have stochastic equations for corporate tax accruals (equation 73), customs duties (74), excise duties (76), and federal sales taxes (80). The model of the unemployment insurance fund (equations 5, 13, 24, 81 and 82) has also been included because, of all transfer payments, it responds most to changes in the levels of economic activity. The unemployment insurance fund is not only an important automatic stabilizing device, but one whose payments and receipts might from time to time be adjusted for policy reasons. Most of the other transfer payments are less dependent on current levels of economic activity; thus their equations may be fairly safely run outside the aggregate model and the results used as predetermined variables. Since our government sector is quite different from those in existing macro-models, we outline below the structure of the personal income tax model as an example of our procedures.

There are three main steps in the construction of our personal income tax model. The first step involves finding the total number of taxpayers in each income class (equations 46 - 50) and relationships between total personal income and income assessed for taxation purposes (equations 90 - 94). We have used four income classes in order to make proper allowance for progressive tax rates. The usual way of dealing with progressivity in the rate structure is to measure the income elasticity of the tax with respect to past changes in total income, and then assume that the same elasticity will apply with respect to future changes in income. This assumption is inappropriate if the rate structure is not evenly progressive, or if aggregate income changes are not distributed over time in a stable way among income classes. It is worthwhile in any case to have a personal income tax model disaggregated by income level so that the model may be used to simulate the aggregate effects of a wider variety of changes in the level and structure of tax rates. A policy-oriented model of the personal income tax should also identify the nature and amount of exemptions and deductions by income class so that the revenue consequences of changes in these allowances can be assessed more accurately.

The second step in the construction of the tax model is to determine tax accruals (equation 1) on the basis of assessed income, exemptions, and tax rates in each income class. The third step is to estimate the process (equation 79) by which a given

time series of tax accruals gives rise to tax collections and refunds. At all these stages our specifications depend heavily on the nature of the tax regulations, and we naturally spell them out to make explicit the various policy parameters. Since the various fixed and variable lags involved in the tax payment process are explained by our model, it provides a suitable vehicle for testing the dynamic stabilizing properties of the personal income tax.

In later versions of RDX we hope to include our provincial and municipal revenue equations plus expenditures equations, and, in addition, equations that explain the important items linking the government balance on a national accounts basis with government borrowing requirements. In the present model, however, we do take account of the major impact of government financing on financial markets, for we include the government national accounts balance (GBAL) as part of the demand-for-funds variable, which has an important impact on the short-term interest rate (R03).

D. The Financial Sector

The primary role of the financial sector in the RDX1 model is to try to explain financial variables that, according to our conceptual framework, affect directly certain components of aggregate demand or supply or both. In this process additional financial variables, which may or may not be of interest in themselves, are also generated. The incorporation into the model of a financial sector — even though at this stage imperfectly developed — is a first step toward permitting quantitative analysis of the effects of alternative monetary policy actions. An attempt is made, therefore, to incorporate explicitly the cash reserve mechanism through which the Bank of Canada operates. Although there is need for much further study of the possible mechanisms through which central bank operations in financial markets may affect the components of aggregate demand and supply, the present version of RDX1 reflects the view that the influence of these operations is transmitted to the various components of aggregate demand mainly through changes in the yields of various kinds of financial obligations. An explanation of the fluctuations in these yields, therefore, is the primary task of the

financial sector.[3] Credit rationing could in principle also affect every component of aggregate demand. At present, however, such rationing effects are not represented independently of interest rates.

A marketable security's interest yield is the yield implied by the price that achieves a zero excess demand for this particular security. In Canada, as in other countries with developed financial markets, different marketable securities are generally regarded as close substitutes for each other, so that the interest yield on any particular security is influenced by the forces of supply and demand in other markets as well as in its own market. As a result, there is a strong tendency for all interest yields to rise and fall together. Under such conditions it might be helpful to view the determination of various interest rates as occurring in two steps. The first step may be thought of as the determination of a 'key' interest yield. Which rate is chosen to play this role is somewhat arbitrary, and can be determined by the availability of appropriate data or some other 'convenience' criterion. For this model we have selected a short-term money-market rate (the average yield on federal government securities with 3 years or less to maturity) to play this part. We chose this rate for careful examination because central bank operations tend to have their most direct impact on the short-term money market. The main instrument of monetary policy influencing yields in the money market is the level of cash reserves (given the reserve requirements on Canadian deposit liabilities of the chartered banks). Having established the level of this 'key' rate or its determinants, the second step is to take explicit account of investors' preferences and expectations concerning the effect of future security price movements in determining the relative levels of other rates. All interest yields are, of course, jointly determined. However, the above procedure may help to highlight a number of separate factors affecting the general level of bond prices, as well as the configuration of relative yields on different kinds of securities.

[3]No attempt has been made to explain changes in equity yields, as this involves an explanation of the changing value of corporate shares. Fluctuating security prices have important effects on the net worth of the household sector. These 'wealth' effects ought in principle to have significant influences on consumer spending. Unfortunately, there are no reliable estimates of household net worth in Canada and the model, therefore, cannot deal explicitly with this problem.

Our specification of many of the key relationships in financial markets takes account of the openness of the Canadian economy. The financial sector of the model does this by introducing U.S. interest rates as variables in the relationships that describe the formation of Canadian interest rates. As well, the actions of the central bank in supplying cash reserves are undoubtedly heavily influenced by the state of credit in the United States.[4]

In the present model variations in Canadian long-term interest rates are related directly to fluctuations in U.S. long-term rates and to changes in Canadian short-term interest rates (equation 64).[5] The short rate is determined by movements in the U.S. short rate and by variables representing the excess demand for credit (equation 62). These latter variables are (a) the excess of gross private fixed investment over current corporate saving and the national accounts surplus and (b) the rate of expansion of banks' earning liquid assets. The rate of expansion of banks' earning liquid assets is determined by the rate of growth of total bank assets (defined as a multiple of the reserve base),[6] the portfolio-allocation of bank assets between loans (equations 35 and 38) and earning liquid assets.

Both the demand and supply of the chartered banks' deposit liabilities are assumed to be generated by various types of partial-adjustment models whose equilibrium levels are governed by the level of general economic activity, the current and past levels of a whole configuration of interest rates, and the amount of bank reserves provided by the Bank of Canada. There is an independent equation for demand deposits (equation 9), while the

[4]The central bank's actions might be viewed as reflecting some sort of 'reaction function' relating policy tools to targets. Although an explicit function of this kind does not appear in our model, it is clear that the monetary authorities are not indifferent to the size of foreign capital inflows (outflows) and, therefore, are sensitive to foreign (particularly U.S.) interest rates.

[5]Our model does not include a specific treatment of the market for government securities. Thus the quantities of securities never enter the picture. The effects of a government deficit, however, are felt through its contribution to aggregate demand and via its effects on the excess demand for credit. (See equation 62.)

[6]This feature will need to be re-examined as experience accumulates under the differential-reserve requirements of the new Bank Act. Our preliminary hypothesis is that during our sample period the banks continuously strove (over a period as long as a quarter) to maintain close to a zero excess-reserve position.

sum of non-personal term and notice deposits plus personal savings deposits is determined in the model (equation 59) according to the requirement that total bank assets must equal total bank liabilities.

E. International Capital Flows

The model contains specific stochastic relationships for net private short-term and net long-term capital inflows. Government short-term capital movements (mainly changes in official reserves) are explained as a residual in the balance of payments identity (equation 67).[7] In our formulation, the model treats this change in reserves as an endogenous variable, with the foreign exchange rate predetermined. This is a good approximation to reality only during the period of the pegged exchange rate, i.e. after April 1962. Under the fluctuating exchange rate the relationships were in fact reversed — the exchange rate was endogenous and the change in official reserves determined exogenously by the government. Although the fluctuating rate system existed for the larger part of our sample period, the current system is based on a pegged exchange rate and we geared the model to the present regime to increase the relevance of RDX1 to contemporary problems. Similarly, the foreign price variables (PWXG, PMG and PMS) were not really predetermined in the period of the fluctuating exchange rate. Since they are converted to Canadian dollars by the use of the current exchange rate, some of their variance should be regarded as endogenous during the flexible-rate period. Nevertheless, we treat these prices as predetermined throughout the time period.

The principal explanatory variable in both capital-account equations is an interest-rate differential. In view of the preponderant importance of the United States in capital movements involving Canada, the differential is a Canadian-U.S. one. For long-term capital, we should like to use long-term federal government interest rates. However, the lack of either active trading

[7] The balance-of-payments flows comprising this residual include, in addition to changes in official reserves, Columbia River Treaty receipts, Government of Canada loans and subscriptions, and "other long-term capital movements" as defined in the balance of payments. See [2].

in, or new issues of, U.S. federal long-term securities makes their yields unrepresentative of U.S. interest rates. Therefore we couple the average yield on long-term Canada bonds with a U.S. corporate-bond yield. For short-term capital, treasury bill rates are used. The interest-rate differential is tried in both current and distributed-lag form. Furthermore, both the differential itself and its first difference are employed alternatively. Regardless of the form, we expect a positive interest effect, or, in the case of a complicated distributed lag, at least a net positive effect. In fact the current interest differential (the pure 'flow' theory of capital movements, with immediate adjustment) produces equations with the highest explanatory power.

In addition to the interest differential, two dichotomous variables enter the equation determining net long-term-capital inflow (equation 39). One refers to the time period of the U.S. interest equalization tax (3Q63 onward) and the other to the Canadian-U.S. agreement on deferment of deliveries of new issues of securities sold to U.S. residents (4Q65). Both effects should be negative. It is true that an important exemption from the interest equalization tax was provided for new (though not outstanding) issues of Canadian securities. However, we view the dichotomous variable as representing (albeit in an oversimplified manner) the fundamental change in the balance-of-payments policy of the U.S. government — the shift to capital controls, voluntary and involuntary, in addition to the interest equalization tax itself. As far as portfolio capital movements are concerned, perhaps the most sensitive indicator of the demand for funds is the amount of net new issues of provincial and municipal securities because provinces and municipalities are the chief users of foreign capital markets (principally the New York capital market).

Thus far we have analyzed long-term capital as if it were all portfolio investment. To take account of direct investment, we use the following activity variable:

(IME + INRC)PGNE

In addition to the activity variable itself, we find its interaction with a time trend is a significant explanatory variable with a negative effect. This suggests that over time there has been a decreasing resort to external funds to finance fixed investment in Canada.

The equation explaining short-term capital movements (equation 69) specifies the uncovered short-term interest differential between Canada and the United States, as well as the change in the exchange rate. This latter variable is interpreted as an expectations variable (concerning future movements in the exchange rate) affecting short-term speculative flows of capital. The formulation of the relationship, however, allows for the differential effect of this variable during the fluctuating rate period (1Q53 - 2Q61), during the period of uncertainty in the foreign exchange market (3Q61 - 2Q62), (which witnessed a large-scale government intervention in that market) and during the period of the fixed exchange rate (starting in 3Q62). In order to explain the U.S. balance-of-payments guidelines inaugurated February 10, 1965, we use a dichotomous variable with the value 1 in the period 1Q65 - 4Q65 and 0 otherwise. One would expect the direct effect of the guidelines to be negative, lessening the outflow of capital from the United States. However, at this same time, the Canadian chartered banks were moving substantial blocks of short-term funds from Europe to Canada. The latter movement was large enough to swamp the movement from Canada to the U.S., so that the dummy variable takes a positive coefficient.

To take account of direct substitution between short-term and long-term capital movements, we include the long-term capital flow as an explanatory variable in the equation for short-term capital movements. With the inclusion of long-term capital as an explanatory variable, we regard the positive effects of the dichotomous variable as temporary and restrict this variable in simulation to be zero outside our estimation period.

3. Conclusion

The equations which we have described in the preceding pages together comprise the structure of RDX1. Although we have done a number of simulation experiments with this and earlier versions of the complete model in order to ensure that the system has plausible dynamic properties, the performance of the model is still not fully satisfactory in several respects. As we state in the preface, these deficiencies are considered in some detail in a companion paper. In that paper we will also present the results of a wide range of simulation experiments showing how the model

might be used to help expose the consequences of the alternatives open to Canadian economic policy.

We are publishing the structure of RDX1 now, along with its data base and associated computer programs, so that other researchers can test alternative specifications, and adapt the model for their own purposes. Though the equations of RDX1 fit the 1953-1965 data fairly well, there is no guarantee that the model as a whole pictures well enough those aspects of the economic structure that will interest particular users. There is even less chance that the model will continue to fit the data generated since 1965, for several of the changes that have occurred in the structure of the economy during the last four years would affect materially the appropriate specification of aggregate equations.

The next version of RDX (whose data will include 1966 and 1967), will undoubtedly be much different in several respects. In the meantime, we hope the ready availability of RDX1 will encourage others to offer criticisms, suggestions, and improvements that will help to make RDX2 a better model than we could construct unaided.

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A P P E N D I X   A

SECTORAL BREAKDOWN OF RDX1

A. PRIVATE AGGREGATE DEMAND

1. Consumer Expenditures
    1. Consumer Expenditure, Durables (CD) - Equation 2
    2. Consumer Expenditure, Non-Durables (CND) - Equation 7
    3. Consumer Expenditure, Services (CS) - Equation 8

2. Residential Construction
    1. Construction Costs (CLC) - Equation 6
    2. Housing Starts (HST) - Equation 21
    3. Investment, Residential Construction (IRC) - Equation 26
    4. Stock of Houses (STH) - Equation 68
    5. Conventional Mortgage Rate (RC) - Equation 63
    6. Price of Houses (PH) - Equation 57

   Technical Relationships and Identities
    1. Estimated Logarithm of Investment in Non-Residential Construction (LINE) - Equation 36
    2. Estimated Logarithm of Investment in Residential Construction (LIRE) - Equation 37
    3. Mortgage Rate (RM) - Equation 66

3. Gross Private Business Investment
    1. Investment, Machinery and Equipment (IME) - Equation 22
    2. Investment, Non-Residential Construction (INRC) - Equation 23
    3. Change in Non-Farm Business Inventories (INV) - Equation 25

   Technical Relationships and Identities
    1. Cash Flow Ratio (CFR) - Equation 3
    2. Trended Cash Flow Ratio (CFRT) - Equation 4
    3. Stock of Non-Farm Inventories (H) - Equation 16
    4. Stock of Machinery and Equipment (KME) - Equation 27
    5. Desired Stock of Machinery and Equipment (KMED) - Equation 28
    6. Gap between Desired and Actual Stock of Machinery and Equipment (KMEG) - Equation 29
    7. Trended Stock of Machinery and Equipment (KMEY) - Equation 30
    8. Stock of Non-Residential Construction (KNR) - Equation 31
    9. Desired Stock of Non-Residential Construction (KNRD) - Equation 32
    10. Gap between Desired and Actual Stock of Non-Residential Construction (KNRG) - Equation 33
    11. Trended Stock of Non-Residential Construction (KNRY) - Equation 34
    12. Undistributed Corporate Profits (PCRT) - Equation 53
    13. Long-Term Interest Rate Index (RLCI) - Equation 65
    14. Real Domestic Product less Agriculture (Y) - Equation 89
    15. Capacity Real Domestic Product less Agriculture (YC) - Equation 95

4. Foreign Trade
    1. Imports of Goods (MG) - Equation 40
    2. Imports of Services (MS) - Equation 41
    3. Exports of Goods (XG) - Equation 87
    4. Exports of Services (XS) - Equation 88

B. EMPLOYMENT, PRICES, AND INCOME DISTRIBUTION

1. Employment, Labor Force and Hours
    1. Average Hours Worked, Paid Non-Agricultural Workers (HAW) - Equation 17
    2. Paid Workers, Private Industry (NEPP) - Equation 43
    3. Employed, Unpaid Workers (NEUP) - Equation 44
    4. Labor Force (NL) - Equation 45

    Technical Relationships and Identities
    1. Trended Average Hours Worked (HAWT) - Equation 18
    2. Paid Workers, Total (NEP) - Equation 42
    3. Total Unemployed (NU) - Equation 51

2. Wages
    1. Private Wage Rate Per Man-hour (WPH) - Equation 85

    Technical Relationships and Identities
    1. Government Wage Expenditure (GW) - Equation 15
    2. Private Wages (WP) - Equation 84
    3. The Wage Bill (WSSL) - Equation 86

3. Prices
    1. Implicit Price Index, Consumer Durable Expenditure (PD) - Equation 55
    2. Implicit Private GNE Deflator (PGNE) - Equation 56
    3. Implicit Price Index, Consumer Non-Durable Expenditure (PND) - Equation 58
    4. Price Index, Goods Exports (PXG) - Equation 60
    5. Price Index, Service Exports (PXS) - Equation 61

    Technical Relationships and Identities
    1. Inventory Stock/Sales Ratio (HSL) - Equation 19
    2. Trended Inventory Stock/Sales Ratio (HSLT) - Equation 20
    3. Private Unit Labour Costs (ULC) - Equation 83

4. Income Components
    1. Dividends Paid to Canadians (DIVC) - Equation 10
    2. Dividends Paid to Foreigners (DIVF) - Equation 11
    3. Corporate Profits (PC) - Equation 52

    Technical Relationships and Identities
    1. Real Disposable Personal Income (YD) - Equation 96
    2. Permanent Real Disposable Personal Income (YDP) - Equation 97
    3. Gross National Expenditure (YGNE) - Equation 98
    4. Private Non-Farm Real Gross National Expenditure (YGPK) - Equation 99
    5. Personal Income (YP) - Equation 100
    6. Simulated Income-Expenditure Residual (YRES) - Equation 101

C. THE GOVERNMENT SECTOR

1. Person Direct Taxes Sub-Model
    1. Total Number of Taxable Persons (NT) - Equation 46
    2. Total Personal Direct Taxes (TP) - Equation 79
    3. Assessed Taxable Income (YAS) - Equation 90

   Technical Relationships and Identities
    1. Accrued Personal Income Tax (AY) - Equation 1
    2. Number of Taxable Persons, Assessed Incomes between 0 and $3,000 (NT03) - Equation 47
    3. Number of Taxable Persons, Assessed Incomes between $3,000 and $5,000 (NT35) - Equation 48
    4. Number of Taxable Persons, Assessed Incomes between $5,000 and $10,000 (NT51) - Equation 49
    5. Number of Taxable Persons, Assessed Incomes over $10,000 (NT10) - Equation 50
    6. Assessed Taxable Income between 0 and $3,000 (YAS1) - Equation 91
    7. Assessed Taxable Income between $3,000 and $5,000 (YAS2) - Equation 92
    8. Assessed Taxable Income between $5,000 and $10,000 (YAS3) - Equation 93
    9. Assessed Taxable Income over $10,000 (YAS4) - Equation 94

2. Other Tax Equations

   Government Revenue
    1. Corporate Tax Accruals (TCA) - Equation 73
    2. Customs Duties (TCUS) - Equation 74
    3. Excise Taxes (TEX) - Equation 76
    4. Federal Sales Tax (TS) - Equation 80

   Technical Relationships and Identities
    1. Government Balance (GBAL) - Equation 14
    2. Total Indirect Taxes (TI) - Equation 77
    3. Taxable Corporate Profits (PCT) - Equation 54

3. Unemployment Insurance Fund Sub-Model
    1. Claimants Insured by Unemployment Insurance Fund (CL) - Equation 5
    2. Average Level of Enrolment in Unemployment Insurance Fund (INS) - Equation 24
    3. Unemployment Insurance Benefits (UIB) - Equation 81
    4. Unemployment Insurance Receipts (UIR) - Equation 82

   Technical Relationships and Identities
    1. Employed Contributors to Unemployment Insurance Fund (EMPS) - Equation 13

D. THE FINANCIAL SECTOR

1. Chartered Banks' Demand Deposits (DD) - Equation 9
2. Chartered Banks' Loans to Business (LB) - Equation 35
3. Chartered Banks' Loans to Persons (LP) - Equation 38
4. Short-Term Interest Rate (R03) - Equation 62
5. Long-Term Interest Rate (RLC) - Equation 64
6. Chartered Banks' Total Loan Authorizations over $100,000 (TA) - Equation 70

Technical Relationships and Identities

1. Chartered Banks' More Liquid Assets (ELA) - Equation 12
2. Chartered Banks' Personal Savings Deposits and Non-Personal Term Deposits (PNPS) - Equation 59
3. Chartered Banks' Total Major Assets (TBA) - Equation 71
4. Chartered Banks' Trended Total Major Assets (TBAT) - Equation 72
5. Chartered Banks' Total Deposits (TD) - Equation 75
6. Chartered Banks' Total Loans (TL) - Equation 78

E. INTERNATIONAL CAPITAL FLOWS

1. Net Long-Term Capital Inflows (LTK) - Equation 39
2. Net Private Short-Term Capital Inflows (STK) - Equation 69

Technical Relationships and Identities

1. Change in Reserves as Defined by the Balance of Payments (RSR) - Equation 67

A P P E N D I X   B

RDX1 STRUCTURAL EQUATIONS

O.L.S. = Ordinary least squares

T.S.F. = Two-stage Fisher

$\overline{R}^2$ = Adjusted coefficient of determination

SEE = Standard error of estimate

COV = Coefficient of variation, as a percentage

D/W = Durbin/Watson statistic

O.L.S. coefficients above, T.S.F. below

t-statistics are in brackets

1. Accrued Personal Income Tax, 1Q50 - 4Q65

$$AY = \sum_{i=1}^{i=4} RW_i \; (YAS_i - NT_i YEX_i) - RDC\;(DIVC)$$

2. Consumer Expenditure, Durables, 1Q52 - 4Q65

$$\begin{array}{llllll}
CD = & 340.6 & - 0.0211\ Q1(YDP) & + 0.0077\ Q2(YDP) & - 0.0318\ Q3(YDP) & + 0.3500\ YDP \\
 & (3.06) & (8.31) & (3.38) & (7.11) & (11.68) \\
 & 373.0 & - 0.0211 & 0.0076 & - 0.0315 & 0.3584 \\
 & (1.91) & (8.20) & (3.30) & (6.73) & (7.00)
\end{array}$$

$$\begin{array}{llll}
+ 0.0662\ (\frac{YD}{PGNE} - YDP) & - 0.2551\ YDP\ (\frac{PD}{PGNE}) & - 44.62\ RLC_{t-3} \\
(2.47) & (4.52) & (2.86) \\
0.0627 & - 0.2721 & - 41.53 \\
(2.33) & (2.70) & (1.92)
\end{array}$$

O.L.S. $\bar{R}^2 = 0.962$
SEE = 33.83
COV = 5.107
D/W = 1.97

T.S.F. $\bar{R}^2 = 0.962$
SEE = 33.87
COV = 5.11
D/W = 1.95

3. Cash Flow Ratio

$$CFR = (\frac{CCAC + PCRT}{PGNE})/CFRT$$

4. Trended Cash Flow Ratio, 1Q50 - 4Q65

$$\begin{array}{lll}
CFRT = & 272.1 & + 8.698\ T \\
 & (9.01) & (13.88)
\end{array}$$

O.L.S. $\bar{R}^2 = 0.752$
SEE = 92.61
COV = 14.05
D/W = 1.48

5. Claimants on the Unemployment Insurance Fund, 1Q52 - 4Q65

$$\begin{array}{llllll}
CL = & -0.2128 & - 0.00328\ T & + 0.1064\ INS & + 1.218\ Q1(NU) & + 1.0621\ Q2(NU) \\
 & (2.32) & (3.30) & (3.00) & (22.42) & (13.78) \\
 & -0.2548 & - 0.00372 & 0.1225 & 1.218 & 1.066 \\
 & (1.98) & (2.77) & (2.45) & (21.14) & (13.43)
\end{array}$$

$$
\begin{array}{ll}
+\ 0.7248\ Q3(NU) & +\ 1.020\ Q4(NU) \\
\ \ (6.76) & \ \ (11.71) \\
\ \ 0.7318 & \ \ 1.025 \\
\ \ (6.64) & \ \ (11.30)
\end{array}
$$

O.L.S.	$\overline{R}^2 = 0.953$	T.S.F.	$\overline{R}^2 = 0.953$
	SEE = 0.0416		SEE = 0.0417
	COV = 11.26		COV = 11.28
	D/W = 1.92		D/W = 1.91

6. Construction Costs, 3Q55 - 4Q65

$$
\begin{array}{lll}
\ln CLC - \ln CLC_{t-4} = & -0.00356 & +\ 0.0418\ (\ln INRC - LINE)_{t-1} \\
 & \ \ (.61) & \ \ (1.93) \\
 & -0.00315 & \ \ 0.0445 \\
 & \ \ (.49) & \ \ (1.90)
\end{array}
$$

$$
\begin{array}{ll}
+\ 0.0902\ (\ln IRC - LIRE)_{t-1} & +\ 0.1246\ (\ln WC - \ln WC_{t-4}) \\
\ \ (3.88) & \ \ (1.09) \\
\ \ 0.0850 & \ \ 0.0781 \\
\ \ (3.45) & \ \ (.63)
\end{array}
$$

$$
\begin{array}{ll}
+\ 0.1122\ (\ln L - \ln L_{t-4}) & +\ 0.0311\ (\ln R03 - \ln R03_{t-4}) \\
\ \ (2.60) & \ \ (3.34) \\
\ \ 0.1249 & \ \ 0.0377 \\
\ \ (2.26) & \ \ (3.40)
\end{array}
$$

$$
\begin{array}{l}
+\ 0.0279\ DVST \\
\ \ (5.03) \\
\ \ 0.0298 \\
\ \ (5.15)
\end{array}
$$

O.L.S.	$\overline{R}^2 = 0.741$	T.S.F.	$\overline{R}^2 = 0.735$
	SEE = 0.0136		SEE = 0.0138
	D/W = 1.56		D/W = 1.52

7. Consumer Expenditure, Non-Durables, 1Q52 - 4Q65

$$
\begin{array}{llllll}
CND = & 705.7 & -\ 0.1010\ Q1(YDP) & -\ 0.0779\ Q2(YDP) & -\ 0.0845\ Q3(YDP) & +\ 0.9796\ YDP \\
 & (8.92) & \ \ (30.58) & \ \ (26.18) & \ \ (14.76) & \ \ (12.73) \\
 & 589.8 & -\ 0.1012 & -\ 0.0775 & -\ 0.0830 & \ \ 0.8580 \\
 & (5.49) & \ \ (30.00) & \ \ (25.38) & \ \ (14.65) & \ \ (\ 7.82)
\end{array}
$$

$$+ 0.0673 \left(\frac{YD}{PGNE} - YDP\right) - 0.5556\ YDP \left(\frac{PND}{PGNE}\right)$$
(1.94) (6.20)

0.0559 - 0.4128
(1.63) (3.23)

O.L.S. $\overline{R}^2 = 0.992$
SEE = 44.39
COV = 1.63
D/W = 2.34

T.S.F. $\overline{R}^2 = 0.992$
SEE = 45.54
COV = 1.67
D/W = 2.13

8. Consumer Expenditure, Services, 1Q52 - 4Q65

$$CS = -149.7 - 0.000403\ Q1(YDP) + 0.00856\ Q2(YDP) - 0.0113\ Q3(YDP) + 0.3813\ YDP$$
(5.84) (.19) (3.97) (5.32) (82.47)

-152.1 - 0.000403 0.00857 - 0.0113 0.3818
(5.94) (.19) (3.98) (5.32) (82.51)

O.L.S. $\overline{R}^2 = 0.992$
SEE = 32.29
COV = 1.64
D/W = .91

T.S.F. $\overline{R}^2 = 0.992$
SEE = 32.30
COV = 1.64
D/W = .91

9. Demand Deposits, 1Q55 - 4Q65

$$\frac{DD - DD_{t-1}}{TBA} = 0.0840 - 0.0158\ Q1 - 0.00561\ Q2 - 0.00473\ Q3 - 0.2526\ \frac{DD_{t-1}}{TBA}$$
(3.24) (5.37) (2.92) (1.52) (6.11)

0.0742 - 0.0152 - 0.00549 - 0.00560 - 0.2426
(2.73) (4.91) (2.84) (1.71) (5.60)

$$+ 0.03655\ \frac{YGNE}{TBA} - 0.00825\ R03 + 0.000247\ S^2_{t-1}$$
(1.12) (7.82) (2.51)

0.0484 - 0.00869 0.000262
(1.38) (7.42) (2.61)

O.L.S. $\overline{R}^2 = 0.840$
SEE = 0.0043
D/W = 1.75

T.S.F. $\overline{R}^2 = 0.838$
SEE = 0.0044
D/W = 1.77

10. Dividends Paid to Residents, 1Q53 - 4Q65

$$DIVC = -22.00 - 13.23\ Q2 - 19.70\ Q3 + 0.0781\ (PC + CCAC - TCA)$$
(2.91) (2.87) (4.26) (20.13)

-21.39 - 13.23 - 19.68 0.0778
(2.79) (2.87) (4.26) (19.77)

$$+ \underset{(20.13)}{0.0440} (PC + CCAC - TCA)_{t-1} + \underset{(20.13)}{0.0195} (PC + CCAC - TCA)_{t-2}$$

$$\underset{(19.77)}{0.0438} \qquad \underset{(19.77)}{0.0195}$$

$$+ \underset{(20.13)}{0.0049} (PC + CCAC - TCA)_{t-3}$$

$$\underset{(19.77)}{0.0049}$$

O.L.S.		T.S.F.	
$\overline{R}^2$	= 0.891	$\overline{R}^2$	= 0.891
SEE	= 13.59	SEE	= 13.59
COV	= 11.96	COV	= 11.97
D/W	= 0.57	D/W	= 0.57

11. Dividends Paid to Non-Residents, 1Q53 - 4Q65

$$DIVF = \underset{(3.98)}{53.19} - \underset{(5.65)}{37.93}\, Q1 - \underset{(8.78)}{57.23}\, Q2 - \underset{(8.97)}{57.97}\, Q3 + \underset{(2.16)}{15.89}\, D8$$

$$\underset{(3.53)}{48.69} - \underset{(5.53)}{37.26} \quad - \underset{(8.71)}{56.88} \quad - \underset{(8.93)}{57.80} \quad \underset{(1.84)}{13.84}$$

$$+ \underset{(7.81)}{0.0586} (PC + CCAC - TCA) + \underset{(7.81)}{0.0329} (PC + CCAC - TCA)_{t-1}$$

$$\underset{(7.88)}{0.0613} \qquad \underset{(7.88)}{0.0345}$$

$$+ \underset{(7.81)}{0.0146} (PC + CCAC - TCA)_{t-2} + \underset{(7.81)}{0.0037} (PC + CCAC - TCA)_{t-3}$$

$$\underset{(7.88)}{0.0153} \qquad \underset{(7.88)}{0.0038}$$

O.L.S.		T.S.F.	
$\overline{R}^2$	= 0.874	$\overline{R}^2$	= 0.874
SEE	= 16.43	SEE	= 16.46
COV	= 12.76	COV	= 12.78
D/W	= 2.08	D/W	= 2.09

12. Chartered Banks More Liquid Assets

$$ELA = TBA - TL - OCS - VC - BCD$$

13. Employed Contributors to Unemployment Insurance Fund

$$EMPS = INS - CL$$

14. Government Balance

$$GBAL = TP + TOP + TCA + TI + TW + GIM + SSPS + UIR + GX - GW - GNW - MP - GTR - UIB - GINT - SUBS - ASST$$

15. Government Wage Expenditure

$$GW = WG(NEPG) + (GWI)$$

16. Stock of Non-farm Inventories

$$H = H_{t-1} + INV$$

17. Average Weekly Hours Worked, Paid Non-agricultural Workers, 1Q54 - 4Q65

$$\begin{array}{llllll} HAW - HAW_{t-1} = & 53.36\ Q1 & +\ 54.88\ Q2 & +\ 53.97\ Q3 & +\ 52.70\ Q4 & -\ 0.01323\ TQ1 \\ & (8.68) & (8.98) & (8.47) & (8.39) & (0.84) \\ & 53.86 & 55.41 & 54.55 & 53.24 & -\ 0.01710 \\ & (4.68) & (4.84) & (4.57) & (4.54) & (1.01) \end{array}$$

$$\begin{array}{llll} -\ 0.02495\ TQ2 & -\ 0.03608\ TQ3 & -\ 0.01908\ TQ4 & +\ 0.0006242\ (YGPK + \frac{GNW}{PGNE}) \\ (1.49) & (2.01) & (1.00) & (3.13) \\ -\ 0.02972 & -\ 0.04125 & -\ 0.02462 & 0.0007059 \\ (1.61) & (2.04) & (1.09) & (2.34) \end{array}$$

$$\begin{array}{lll} +\ 0.01895\ \frac{NL}{NU} & -\ 5.087\ WPH & -\ 1.230\ HAW_{t-1} \\ (2.41) & (4.03) & (8.51) \\ 0.01577 & -\ 5.272 & -\ 1.243 \\ (1.69) & (2.84) & (4.69) \end{array}$$

O.L.S. $\bar{R}^2 = 0.973$
SEE = 0.209
D/W = 1.90

T.S.F. $\bar{R}^2 = 0.973$
SEE = 0.209
D/W = 1.84

18. Trended Average Weekly Hours Worked, 3Q53 - 4Q65

$$\begin{array}{lllllll} HAWT = & 41.13\ Q1 & +\ 43.21\ Q2 & +\ 42.48\ Q3 & +\ 40.75\ Q4 & -\ 0.0340\ T(Q1) & -\ 0.0423\ T(Q2) \\ & (126.5) & (130.5) & (146.5) & (138.1) & (5.53) & (6.88) \end{array}$$

$$\begin{array}{ll} -\ 0.0607\ T(Q3) & -\ 0.0276\ T(Q4) \\ (11.13) & (5.06) \end{array}$$

O.L.S. $\bar{R}^2 = 0.912$
SEE = 0.294
COV = 0.74
D/W = 1.41

19. Inventories Sales Ratio

$$HSL = \frac{H_{t-1}}{YGPK + (GNW/PGNE) - INV}$$

20. Trended Inventories Sales Ratio, 1Q50 - 4Q65

$$\underset{(49.2)}{HSLT = 1.302} - \underset{(3.7)}{0.002057}\ T$$

O.L.S. $\bar{R}^2 = 0.172$
SEE = 0.08
COV = 6.70
D/W = 2.0

21. Housing Starts, 1Q57 - 4Q65

$$\begin{array}{llllllll}
HST = & 28.58 & - 20.21\ Q1 & + 7.984\ Q2 & + 7.766\ Q3 & + 9.350\ WW & + 9.258\ (\frac{PH}{CLC}) \\
 & (.96) & (8.67) & (3.76) & (3.89) & (2.55) & (3.16) \\
 & 17.19 & - 20.20 & 7.810 & 7.500 & 8.708 & 10.94 \\
 & (.55) & (8.62) & (3.65) & (3.72) & (2.34) & (3.37)
\end{array}$$

$$\begin{array}{llll}
- 12.03\ RM_{t-1} & + 2.662\ (RM - RLC)_{t-1} & + 2.868\ (\frac{CMHC}{PH}) & + 5.810\ (\frac{CMHC}{PH})_{t-1} \\
(3.85) & (1.27) & (1.31) & (3.69) \\
- 12.55 & 3.244 & 3.083 & 5.771 \\
(3.96) & (1.50) & (1.40) & (3.65)
\end{array}$$

O.L.S. $\bar{R}^2 = 0.922$
SEE = 3.52
COV = 9.96
D/W = 1.84

T.S.F. $\bar{R}^2 = 0.921$
SEE = 3.55
COV = 10.03
D/W = 1.83

22. Investment, Machinery and Equipment, 1Q53 - 4Q65

$$\begin{array}{llllll}
IME - 0.05\ KME_{t-1} = & -212.8\ Q1 & - 132.7\ Q2 & - 271.0\ Q3 & - 233.6\ Q4 & + 0.1654\ Q1(KMEG) \\
 & (3.84) & (1.87) & (3.97) & (3.72) & (5.58) \\
 & -269.3 & - 205.9 & - 341.5 & - 298.1 & 0.1604 \\
 & (3.40) & (2.02) & (3.47) & (3.30) & (5.27)
\end{array}$$

$$\begin{array}{llll}
+ 0.1665\ Q2(KMEG) & + 0.1442\ Q3(KMEG) & + 0.1977\ Q4(KMEG) & + 317.9\ CFR \\
(5.61) & (5.22) & (7.40) & (5.09) \\
0.1585 & 0.1409 & 0.1929 & 383.2 \\
(5.18) & (5.01) & (7.05) & (4.23)
\end{array}$$

O.L.S. $\bar{R}^2 = 0.878$ T.S.F. $\bar{R}^2 = 0.875$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.878	$\bar{R}^2$	= 0.875
SEE	= 38.46	SEE	= 38.94
COV	= 45.26	COV	= 45.83
D/W	= .87	D/W	= .88

23. Investment, Non-residential Construction 1Q53 - 4Q65

$$
\begin{array}{lllll}
INRC - 0.01\ KNR_{t-1} = & -1.052\ T(Q1) & +\ 1.878\ T(Q2) & +\ 4.714\ T(Q3) & +\ 2.942\ T(Q4) \\
 & (2.47) & (4.52) & (11.50) & (7.33)
\end{array}
$$

$$
\begin{array}{ll}
+\ 0.0299\ KNRG & +\ 299.1\ RLCI \\
(13.25) & (15.13)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.931$
SEE = 37.36
COV = 10.46
D/W = 1.25

24. Level of Enrolment in Unemployment Insurance Fund, 1Q52 - 4Q65

$$
\begin{array}{llllll}
INS = & -0.4422\ Q1 & -\ 0.7563\ Q2 & -\ 0.9460\ Q3 & -\ 0.7588\ Q4 & +\ 0.9695\ NEP(D5) \\
 & (.48) & (.80) & (.96) & (.79) & (3.70) \\
 & -2.375 & -\ 2.770 & -\ 3.033 & -\ 2.796 & 1.524 \\
 & (2.14) & (2.34) & (2.53) & (2.39) & (4.78)
\end{array}
$$

$$
\begin{array}{lll}
+\ 1.002\ NEP(D6) & +\ 0.00218\ T1(NEP)(D5) & -\ 0.00346\ T2(NEP)(D6) \\
(4.90) & (1.21) & (2.08) \\
1.435 & 0.00151 & -\ 0.00680 \\
(5.77) & (.69) & (3.41)
\end{array}
$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.956	$\bar{R}^2$	= 0.952
SEE	= 0.098	SEE	= 0.102
COV	= 2.52	COV	= 2.63
D/W	= 1.12	D/W	= 1.20

25. Change in Non-farm Business Inventories, 1Q56 - 4Q65

$$
\begin{array}{llllll}
INV = & 626.7 & +\ 326.4\ Q1 & +\ 160.3\ Q2 & -\ 39.45\ Q3 & -\ 0.1351\ H_{t-1} \\
 & (3.80) & (2.83) & (1.91) & (0.85) & (3.02) \\
 & 610.6 & 366.8 & 58.80 & -\ 83.63 & -\ 0.0830 \\
 & (3.68) & (3.05) & (0.55) & (1.54) & (1.63)
\end{array}
$$

$$
\begin{array}{ll}
+\ 0.1601\ \left(YGPK - CS - INV + \frac{GNW}{PGNE}\right) & -\ 0.1896\ \left[\left(YGPK - CS - INV + \frac{GNW}{PGNE}\right)\right. \\
(2.65) & (2.26) \\
0.0855 & -\ 0.1020 \\
(1.21) & (0.95)
\end{array}
$$

$$- \left(YGPK - CS - INV + \frac{GNW}{PGNE}\right)_{t-1}\Big] \underset{(5.74)}{- 271.9} \frac{NU}{\sum_{i=1}^{12} NU_{t-1}/12} \underset{(5.64)}{- 287.9}$$

O.L.S. $\bar{R}^2 = 0.809$
SEE = 72.43
D/W = 1.70

T.S.F. $\bar{R}^2 = 0.797$
SEE = 74.62
D/W = 1.80

26. Investment, Residential Construction, 1Q54 - 4Q65

$$IRC = \underset{(6.62)}{117.2} + \underset{(16.96)}{4.616}\ HST + \underset{(7.69)}{1.958}\ HST_{t-1} + \underset{(3.32)}{0.9238}\ HST_{t-2}$$

$$\underset{(6.56)}{117.9} \quad \underset{(16.42)}{4.600} \quad \underset{(7.70)}{1.958} \quad \underset{(3.29)}{0.9179}$$

O.L.S. $\bar{R}^2 = 0.886$
SEE = 22.06
COV = 5.91
D/W = 1.05

T.S.F. $\bar{R}^2 = 0.886$
SEE = 22.06
COV = 5.91
D/W = 1.05

27. Stock of Machinery and Equipment

$$KME = KME_{t-1} + IME - 0.05\ KME_{t-1}$$

28. Desired Stock of Machinery and Equipment

$$KMED = Y(KMEY)$$

29. Gap between Desired and Actual Stock of Machinery and Equipment

$$KMEG = 0.1000\ (KMED_{t-1} - KME_{t-2}) + 0.1500\ (KMED_{t-2} - KME_{t-3})$$

$$+ 0.3000\ (KMED_{t-3} - KME_{t-4}) + 0.2500\ (KMED_{t-4} - KME_{t-5})$$

$$+ 0.1500\ (KMED_{t-5} - KME_{t-6}) + 0.0500\ (KMED_{t-6} - KME_{t-7})$$

30. Trended Stock of Machinery and Equipment

$$KMEY = 1.903 - 0.0068\ T + 0.0061\ T(D7) - 0.4157\ D7$$

31. Stock of Non-residential Construction

$$KNR = (KNR_{t-1} + INRC) - 0.0100\ KNR_{t-1}$$

32. Desired Stock of Non-residential Construction

$$KNRD = Y(KNRY)\ CFR$$

33. Gap between Desired and Actual Stock of Non-residential Construction

$$KNRG = 0.0600\ (KNRD_{t-2} - KNR_{t-3}) + 0.1100\ (KNRD_{t-3} - KNR_{t-4})$$

$$+ 0.1600\ (KNRD_{t-4} - KNR_{t-5}) + 0.1700\ (KNRD_{t-5} - KNR_{t-6})$$

$$+ 0.1600\ (KNRD_{t-6} - KNR_{t-7}) + 0.1300\ (KNRD_{t-7} - KNR_{t-8})$$

$$+ 0.1100\ (KNRD_{t-8} - KNR_{t-9}) + 0.0700\ (KNRD_{t-9} - KNR_{t-10})$$

$$+ 0.0400\ (KNRD_{t-10} - KNR_{t-11})$$

34. Trended Stock of Non-residential Construction

$$KNRY = 3.103 + 0.0093\ T$$

35. Chartered Banks' Loans to Business, 1Q57 - 4Q65

$$LB - LB_{t-1} = \underset{(4.23)}{-308.0} - \underset{(2.99)}{0.0224}\ Q1(LB_{t-1}) + \underset{(4.09)}{0.0373}\ Q2(LB_{t-1}) + \underset{(6.08)}{0.0437}\ Q3(LB_{t-1})$$

$$- \underset{(3.90)}{0.3111}\ LB_{t-1} + \underset{(4.16)}{0.1514}\ TA + \underset{(2.14)}{0.1286}\ [PGNE\ (IME + INRC + INV)$$

$$- CCAC - PCRT] + \underset{(3.26)}{48.62}\ R03$$

O.L.S. $\bar{R}^2 = 0.820$
SEE = 44.28
D/W = 0.92
$\rho = 0.419$

36. Estimated Logarithm of Investment in Non-residential Construction, 1Q53 - 4Q65

$$LINE = \underset{(80.6)}{6.152} - \underset{(7.14)}{0.3851}\ Q1 - \underset{(1.70)}{0.9170}\ Q2 + \underset{(2.36)}{0.1276}\ Q3 + \underset{(5.37)}{0.0068}\ T$$

O.L.S. $\bar{R}^2 = 0.718$
SEE = 0.137
COV = 2.14
D/W = .23

37. Estimated Logarithm of Investment in Residential Construction, 1Q53 - 4Q65

$$LIRE = \underset{(93.34)}{5.879} - \underset{(8.22)}{0.3660}\ Q1 - \underset{(2.31)}{0.1029}\ Q2 - \underset{(.17)}{0.0076}\ Q3 + \underset{(2.55)}{0.0027}\ T$$

O.L.S. $\bar{R}^2 = 0.65$
SEE = 0.113
COV = 1.92
D/W = .63

38. Chartered Banks' Loans to Persons, 3Q56 - 4Q65

$$LP - LP_{t-1} = \underset{(7.99)}{-533.8} + \underset{(4.62)}{0.0342}\ TBA - \underset{(2.92)}{0.0124}\ Q1(LP_{t-1}) + \underset{(6.37)}{0.0313}\ Q2(LP_{t-1})$$

$$+ \underset{(9.63)}{0.0377}\ Q3(LP_{t-1}) - \underset{(1.96)}{0.0626}\ LP_{t-1} + \underset{(3.80)}{752.7}\ \left(\frac{ELA}{TBA}\right)_{t-1}$$

$$- \underset{(1.77)}{11.88}\ (RLC - R03)_{t-1}$$

O.L.S. $\bar{R}^2 = 0.890$
SEE = 16.11
D/W = .99
ρ = 0.480

39. Net Long Term Capital Inflow, 1Q53 - 4Q65

$$LTK = \underset{(5.40)}{-\ 632.8} + \underset{(2.88)}{108.2}\ Q1 - \underset{(2.17)}{77.32}\ Q2 - \underset{(2.35)}{92.02}\ Q3 - \underset{(3.76)}{0.00556}\ (T-24)(IME + INRC)\ PGNE$$

$$\underset{(5.21)}{-\ 653.2} \quad \underset{(2.98)}{113.3} \quad \underset{(2.22)}{-\ 79.80} \quad \underset{(2.43)}{-\ 96.25} \quad \underset{(3.48)}{-\ 0.00548}$$

$$+ \underset{(6.64)}{0.7430}\ (IME + INRC)\ PGNE - \underset{(3.77)}{193.0}\ DLK1 - \underset{(1.40)}{140.3}\ DLK4 + \underset{(2.36)}{0.3000}\ PMB$$

$$\underset{(6.32)}{0.7624} \quad \underset{(3.92)}{-\ 201.4} \quad \underset{(1.53)}{-\ 153.4} \quad \underset{(2.24)}{0.2857}$$

$$+ \underset{(2.74)}{177.0}\ (RLC - RLUS)$$

$$\underset{(2.37)}{167.0}$$

O.L.S. $\bar{R}^2 = 0.534$
SEE = 84.25
D/W = 1.53

T.S.F. $\bar{R}^2 = 0.533$
SEE = 84.39
D/W = 1.54

40. Imports of Goods, 1Q53 - 4Q65

$$MG = \underset{\substack{(6.42)\\1461\\(6.08)}}{1506} + \underset{\substack{(4.83)\\76.95\\(4.71)}}{78.70}\,Q1 + \underset{\substack{(11.43)\\174.3\\(11.34)}}{175.4}\,Q2 + \underset{\substack{(1.54)\\22.65\\(1.49)}}{23.37}\,Q3 + \underset{\substack{(42.85)\\1.074\\(42.11)}}{1.080}\,[0.20\,(CD + CND)$$

$$+ 0.21\,(IME + INRC + IRC) + 0.11\,XG + 0.09\,\frac{GNW}{PGNE} + 0.17\,INV]\,(\tfrac{1}{4}) \sum_{i=0}^{3} (\frac{Y}{YC})_{t-i}$$

$$- \underset{\substack{(6.43)\\-586.6\\(6.05)}}{607.6}\,\frac{PMG}{PGNE} - \underset{\substack{(6.43)\\-407.4\\(6.05)}}{422.0}\,(\frac{PMG}{PGNE})_{t-1} - \underset{\substack{(6.43)\\-260.7\\(6.05)}}{270.1}\,(\frac{PMG}{PGNE})_{t-2} - \underset{\substack{(6.43)\\-146.7\\(6.05)}}{151.9}\,(\frac{PMG}{PGNE})_{t-3}$$

$$- \underset{\substack{(6.43)\\-65.18\\(6.05)}}{67.52}\,(\frac{PMG}{PGNE})_{t-4} - \underset{\substack{(6.43)\\-16.30\\(6.05)}}{16.88}\,(\frac{PMG}{PGNE})_{t-5}$$

O.L.S. $\bar{R}^2 = 0.977$
SEE = 38.06
COV = 2.72
D/W = 1.38

T.S.F. $\bar{R}^2 = 0.976$
SEE = 38.10
COV = 2.72
D/W = 1.38

41. Imports of Services, 1Q53 - 4Q65

$$MS - DIVF = \underset{\substack{(2.45)\\-41.80\\(2.50)}}{-40.96} + \underset{\substack{(2.24)\\22.07\\(2.25)}}{21.95}\,Q1 + \underset{\substack{(6.85)\\65.73\\(6.86)}}{65.69}\,Q2 + \underset{\substack{(3.12)\\30.07\\(3.12)}}{30.14}\,Q3 + \underset{\substack{(34.94)\\0.0582\\(34.94)}}{0.0582}\,YGNE$$

O.L.S. $\bar{R}^2 = 0.965$
SEE = 24.36
COV = 4.79
D/W = .88

T.S.F. $\bar{R}^2 = 0.965$
SEE = 24.36
COV = 4.79
D/W = .88

42. Paid Workers, Total, All Industries

NEP = (NEPG + NEPP)

43. Paid Workers, Private Industry, 1Q54 - 4Q65

$$
\begin{array}{llllll}
NEPP - NEPP_{t-1} = & 6.078 & - \; 0.07660 \; Q1 & + \; 0.4346 \; Q2 & + \; 0.2375 \; Q3 \\
 & (6.56) & (3.35) & (15.42) & (17.19) \\
 & 5.996 & - \; 0.09183 & 0.4380 & 0.2410 \\
 & (6.32) & (3.29) & (15.12) & (16.44)
\end{array}
$$

$$
\begin{array}{ll}
+ \; 0.00009238 \; (YGPK + \frac{GNW}{PGNE}) & - \; 0.03897 \; (HAWT - HAW) \\
(3.70) & (2.20) \\
0.00007314 & - \; 0.06718 \\
(2.28) & (2.47)
\end{array}
$$

$$
\begin{array}{ll}
- \; 0.1322 \; HAWT & - \; 0.3780 \; NEPP_{t-1} \\
(6.48) & (5.41) \\
- \; 0.1316 & - \; 0.3303 \\
(6.32) & (3.83)
\end{array}
$$

O.L.S.		T.S.F.	
$\overline{R}^2$	= 0.977	$\overline{R}^2$	= 0.975
SEE	= 0.029	SEE	= 0.030
D/W	= 2.24	D/W	= 2.40

44. Employed, Unpaid Workers, Private Industry, 1Q53 - 4Q65

$$
\begin{array}{lllllll}
NEUP = & 0.2948 & + \; 0.0483 \; Q1 & + \; 0.1569 \; Q2 & + \; 0.1656 \; Q3 & - \; 0.0017 \; T & + \; 0.000175 \; \frac{YNFC}{PGNE} \\
 & (1.84) & (2.01) & (7.68) & (11.24) & (2.80) & (1.47) \\
 & - \; 0.0439 & 0.0735 & 0.1944 & 0.1814 & - \; 0.0009 & 0.000173 \\
 & (.14) & (2.28) & (5.32) & (9.12) & (.99) & (1.36)
\end{array}
$$

$$
\begin{array}{l}
+ \; 0.6643 \; NEUP_{t-1} \\
(6.13) \\
0.9009 \\
(4.12)
\end{array}
$$

O.L.S.		T.S.F.	
$\overline{R}^2$	= 0.928	$\overline{R}^2$	= 0.920
SEE	= 0.022	SEE	= 0.023
COV	= 1.87	COV	= 1.97
D/W	= 1.71	D/W	= 2.01

45. Labor Force, 1Q53 - 4Q65

$$
\begin{array}{lllll}
(\frac{NL}{POP}) - (\frac{NL}{POP})_{t-1} = & -0.00960 & + \; 0.00495 \; Q1 & + \; 0.0153 \; Q2 & + \; 0.0210 \; Q3 \\
 & (8.81) & (2.36) & (8.52) & (15.39) \\
 & -0.00961 & 0.00503 & 0.0153 & 0.0210 \\
 & (5.80) & (.88) & (7.37) & (15.40)
\end{array}
$$

$$+ \underset{(1.32)}{0.0000247} \left[\frac{YGPK}{POP} - \left(\frac{YGPK}{POP}\right)_{t-1}\right] - \underset{(6.35)}{0.6389} \left[\frac{SP}{POP} - \left(\frac{SP}{POP}\right)_{t-1}\right]$$

$$\underset{(.47)}{0.0000255} \qquad - \underset{(6.24)}{0.6401}$$

O.L.S. $\bar{R}^2 = 0.982$
SEE = 0.0017
D/W = 1.88

T.S.F. $\bar{R}^2 = 0.982$
SEE = 0.0017
D/W = 1.88

46. Total Number of Taxable Persons

$$NT = -0.3053 + \underset{(66.86)}{0.7930} (NEP + NEUP) + \underset{(14.35)}{0.02544} T$$

O.L.S. $\bar{R}^2 = 0.987$
SEE = 0.108
COV = 1.98
D/W = .55

47. Number of Taxable Persons, Assessed Incomes between 0 and $3,000

NT03 = N03 (NT)

48. Number of Taxable Persons, Assessed Incomes between $3,000 and $5,000

NT35 = N35 (NT)

49. Number of Taxable Persons, Assessed Incomes between $5,000 and $10,000

NT51 = N51 (NT)

50. Number of Taxable Persons, Incomes over $10,000

NT10 = NT - NT03 - NT35 - NT51

51. Total Unemployed

NU = NL - NEPP - NEUP - NEPG

52. Corporate Profits, 1Q53 - 4Q65

$$PC = \underset{(1.86)}{-1133.} Q1 - \underset{(2.00)}{1169.} Q2 - \underset{(2.40)}{1348.} Q3 - \underset{(2.04)}{1190.} Q4 + \underset{(5.68)}{0.1745} [YGNE - INV(PGNE)]$$

$$\underset{(1.36)}{-904.6} \quad - \underset{(1.52)}{970.1} \quad - \underset{(1.90)}{1164.} \quad - \underset{(1.54)}{985.2} \quad \underset{(5.72)}{0.1941}$$

$$- 1341.\ WPH + 1.768\ (\tfrac{1}{4}) \sum_{i=0}^{i=3} \left(\frac{Y}{NEPP}\right)_{t-i}$$
(5.62) (3.94)

- 1496. 1.702
(5.71) (3.50)

O.L.S. $\bar{R}^2$ = 0.949
SEE = 51.49
COV = 5.87
D/W = 1.38

T.S.F. $\bar{R}^2$ = 0.948
SEE = 51.76
COV = 5.90
D/W = 1.45

53. Undistributed Corporation Profits

PCRT = PC - DIVF - DIVC - TCA - CCB

54. Taxable Corporate Profits, 1Q50 - 4Q65

PCT = 125.1362 + 7.8163 T3 + 0.7591 PC
(6.85) (8.00) (24.32)

O.L.S. $\bar{R}^2$ = 0.997
SEE = 6.91
COV = 0.89
D/W = 1.98

55. Implicit Price Deflator, Consumer Durable Expenditure, 2Q52 - 4Q65

$PD - PD_{t-1}$ = 0.0008 Q1 - 0.0090 Q2 - 0.0162 Q3 + 0.0093 Q4
(.27) (3.03) (4.92) (3.34)

0.00038 - 0.0100 - 0.0181 0.0091
(.13) (2.45) (3.39) (3.50)

+ 0.7603 $(PGNE - PGNE_{t-1})$
(3.57)

0.9966
(1.59)

O.L.S. $\bar{R}^2$ = 0.416
SEE = 0.0104
D/W = 1.73

T.S.F. $\bar{R}^2$ = 0.401
SEE = 0.011
D/W = 1.77

56. Implicit Price Deflator, Gross National Private Expenditure, 1Q55 - 4Q65

PGNE = 0.1537 - 0.01096 Q1 - 0.008114 Q2 - 0.005894 Q3 + 0.00009716 WP
(3.48) (3.26) (1.97) (1.30) (1.46)

0.1638 - 0.01027 - 0.006954 - 0.004147 0.0001164
(3.23) (2.20) (1.10) (0.59) (1.49)

$$+ \underset{(4.24)}{0.3745}\ ULC_t + \underset{(8.50)}{0.3556}\ ULC_{t-1} + \underset{(6.46)}{0.3088}\ ULC_{t-2} + \underset{(4.28)}{0.2339}\ ULC_{t-3}$$

$$\underset{(2.18)}{0.3302} \qquad \underset{(6.48)}{0.3376} \qquad \underset{(4.50)}{0.3083} \qquad \underset{(2.72)}{0.2423}$$

$$+ \underset{(3.29)}{0.1310}\ ULC_{t-4} + \underset{(1.52)}{0.03089}\ PMG_{t-2} + \underset{(1.52)}{0.02270}\ PMG_{t-3} + \underset{(1.52)}{0.01576}\ PMG_{t-4}$$

$$\underset{(2.07)}{0.1395} \qquad \underset{(1.32)}{0.02917} \qquad \underset{(1.32)}{0.02143} \qquad \underset{(1.32)}{0.01488}$$

$$+ \underset{(1.52)}{0.01009}\ PMG_{t-5} + \underset{(1.52)}{0.00567}\ PMG_{t-6} + \underset{(1.52)}{0.00252}\ PMG_{t-7} + \underset{(1.52)}{0.00063}\ PMG_{t-8}$$

$$\underset{(1.32)}{0.00952} \qquad \underset{(1.32)}{0.00536} \qquad \underset{(1.32)}{0.00238} \qquad \underset{(1.32)}{0.00060}$$

$$- \underset{(4.11)}{0.1472} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_t - \underset{(4.11)}{0.0828} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_{t-1}$$

$$- \underset{(2.68)}{0.1200} \qquad\qquad - \underset{(2.68)}{0.0675}$$

$$- \underset{(4.11)}{0.0368} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_{t-2} - \underset{(4.11)}{0.0092} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_{t-3}$$

$$- \underset{(2.68)}{0.0300} \qquad\qquad - \underset{(2.68)}{0.0075}$$

O.L.S.		T.S.F.	
$\overline{R}^2$	= 0.988	$\overline{R}^2$	= 0.988
SEE	= 0.0061	SEE	= 0.0063
COV	= 0.58	COV	= 0.60
D/W	= 1.19	D/W	= 1.19

57. Price of Houses, 1Q57 - 4Q65

$$PH = \underset{(1.80)}{72.20} + \underset{(1.44)}{1.406}\ Q1 + \underset{(3.92)}{4.003}\ Q2 + \underset{(2.18)}{2.036}\ Q3 - \underset{(2.85)}{199.3}\ \frac{STH}{HH} + \underset{(4.74)}{170.2}\ PGNE_{t-1}$$

$$\underset{(1.95)}{79.14} \qquad \underset{(1.49)}{1.467} \qquad \underset{(3.98)}{4.083} \qquad \underset{(2.22)}{2.075} \qquad - \underset{(2.99)}{212.3} \qquad \underset{(4.82)}{174.0}$$

$$+ \underset{(2.94)}{53.20} \left(\frac{YDP}{HH}\right)_{t-1}$$

$$\underset{(3.05)}{55.62}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.914	$\bar{R}^2$	= .914
SEE	= 1.92	SEE	= 1.92
COV	= 1.77	COV	= 1.77
D/W	= 1.11	D/W	= 1.14

58. Implicit Price Deflator, Consumer Non-durable Expenditure, 1Q55 - 4Q65

$$
\begin{array}{llllll}
PND = & 0.3573 & - 0.01077\ Q1 & - 0.008508\ Q2 & - 0.004421\ Q3 & + 0.00009876\ WP \\
 & (12.11) & (4.89) & (3.77) & (1.74) & (2.24) \\
 & 0.3502 & - 0.01102 & - 0.008837 & - 0.005033 & 0.00008730 \\
 & (11.07) & (4.96) & (3.88) & (1.91) & (1.82)
\end{array}
$$

$$
\begin{array}{llll}
+ 0.2744\ ULC_t & + 0.1756\ ULC_{t-1} & + 0.0988\ ULC_{t-2} & + 0.0439\ ULC_{t-3} \\
(7.80) & (7.80) & (7.80) & (7.80) \\
0.2907 & 0.1861 & 0.1047 & 0.04652 \\
(7.42) & (7.42) & (7.42) & (7.42)
\end{array}
$$

$$
\begin{array}{llll}
+ 0.01098\ ULC_{t-4} & + 0.09629\ PMG_{t-2} & + 0.07074\ PMG_{t-3} & + 0.04913\ PMG_{t-4} \\
(7.80) & (5.94) & (5.94) & (5.94) \\
0.01163 & 0.09614 & 0.07063 & 0.04905 \\
(7.42) & (5.75) & (5.75) & (5.75)
\end{array}
$$

$$
\begin{array}{llll}
+ 0.03144\ PMG_{t-5} & + 0.01769\ PMG_{t-6} & + 0.00786\ PMG_{t-7} & + 0.00197\ PMG_{t-8} \\
(5.94) & (5.94) & (5.94) & (5.94) \\
0.03139 & 0.01766 & 0.00785 & 0.00196 \\
(5.75) & (5.75) & (5.75) & (5.75)
\end{array}
$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.987	$\bar{R}^2$	= 0.987
SEE	= 0.0050	SEE	= 0.0050
COV	= 0.48	COV	= 0.48
D/W	= 1.48	D/W	= 1.46

59. Chartered Banks' Personal Savings and Non-Personal Term Deposits

$$PNPS = TD - DD - DG$$

60. Implicit Price Deflator, Goods Exports, 1Q53 - 4Q65

$$
\begin{array}{llll}
PXG = & 0.3154 & + 0.2846\ PGNE & + 0.4018\ PWXG \\
 & (9.53) & (8.28) & (9.31) \\
 & 0.3158 & 0.2822 & 0.4038 \\
 & (9.55) & (8.15) & (9.33)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.902$
SEE = 0.012
COV = 1.20
D/W = 0.63

T.S.F. $\bar{R}^2 = 0.902$
SEE = 0.012
COV = 1.20
D/W = 0.63

61. Implicit Price Deflator, Service Exports, 1Q53 - 4Q65

$$
\begin{array}{llllll}
PXS = & -1.085 & - 0.0198\ Q3 & + 0.5105\ PXG & + 1.593\ PGNE \\
 & (10.73) & (2.52) & (2.97) & (15.93) \\
 & -1.179 & - 0.0197 & 0.6614 & 1.535 \\
 & (10.67) & (2.48) & (3.42) & (13.97)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.963$
SEE = 0.024
COV = 2.29
D/W = 1.55

T.S.F. $\bar{R}^2 = 0.962$
SEE = 0.025
COV = 2.31
D/W = 1.56

62. Short-Term Interest Rate, 3Q53 - 4Q65

$$
\begin{array}{lllll}
R03 = & 3.180 & + 0.5756\ RTUS & + 0.00060\ [(IME + INV + INRC)PGNE - CCA - PCRT - GBAL] \\
 & (4.71) & (6.74) & (4.08) \\
 & 3.214 & 0.5655 & 0.00059 \\
 & (4.54) & (6.30) & (3.74)
\end{array}
$$

$$
\begin{array}{l}
+ 0.00050\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-1} \\
(4.08) \\
0.00049 \\
(3.74)
\end{array}
$$

$$
\begin{array}{l}
+ 0.00040\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-2} \\
(4.08) \\
0.00040 \\
(3.74)
\end{array}
$$

$$
\begin{array}{l}
+ 0.00030\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-3} \\
(4.08) \\
0.00030 \\
(3.74)
\end{array}
$$

$$
\begin{array}{l}
+ 0.00020\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-4} \\
(4.08) \\
0.00020 \\
(3.74)
\end{array}
$$

$$+ \underset{(4.08)}{0.00010}\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-5}$$

$$\underset{(3.74)}{0.00010}$$

$$- \underset{(5.74)}{9.580}\ \frac{ELA}{TBAT} - \underset{(3.43)}{1.558}\ \left(\frac{ELA}{TBAT}\right)_{t-1} + \underset{(4.18)}{2.713}\ \left(\frac{ELA}{TBAT}\right)_{t-2} + \underset{(4.98)}{3.232}\ \left(\frac{ELA}{TBAT}\right)_{t-3}$$

$$\underset{(4.98)}{-10.27} \qquad \underset{(3.31)}{-\ 1.569} \qquad \underset{(3.79)}{3.041} \qquad \underset{(4.35)}{3.564}$$

O.L.S.	$\bar{R}^2$ = 0.876	T.S.F.	$\bar{R}^2$ = 0.875
	SEE = 0.338		SEE = 0.339
	COV = 9.31		COV = 9.33
	D/W = 1.40		D/W = 1.38

63. Conventional Mortgage Rate, 2Q54 - 4Q65

$$RC = \underset{(3.16)}{10.67} + \underset{(3.32)}{0.2508}\ RLC_{t-1} + \underset{(5.43)}{0.4871}\ RNHA - \underset{(7.84)}{0.003741}\ ALTM + \underset{(7.09)}{0.005457}\ MLTM_{t-1}$$

$$\underset{(3.30)}{11.28} \qquad \underset{(3.46)}{0.2667} \qquad \underset{(5.30)}{0.4784} \qquad \underset{(7.84)}{-\ 0.003753} \qquad \underset{(7.19)}{0.005665}$$

$$+ \underset{(3.84)}{3.9927}\ \frac{YDP}{HH} - \underset{(3.25)}{10.6980}\ \left(\frac{STH}{HH}\right)_{t-1}$$

$$\underset{(2.85)}{3.3279} \qquad \underset{(3.20)}{-\ 10.5470}$$

O.L.S.	$\bar{R}^2$ = 0.949	T.S.F.	$\bar{R}^2$ = 0.948
	SEE = 0.097		SEE = 0.098
	COV = 1.44		COV = 1.45
	D/W = 1.25		D/W = 1.26

64. Long-Term Interest Rate, 1Q53 - 4Q65

$$RLC = \underset{(4.71)}{0.1321}\ R03 + \underset{(3.18)}{0.2163}\ RLUS + \underset{(11.28)}{0.6969}\ (RLC)_{t-1}$$

$$\underset{(3.80)}{0.1195} \qquad \underset{(3.05)}{0.2164} \qquad \underset{(10.90)}{0.7071}$$

O.L.S.	$\bar{R}^2$ = 0.975	T.S.F.	$\bar{R}^2$ = 0.975
	SEE = 0.125		SEE = 0.125
	COV = 2.81		COV = 2.81
	D/W = 1.42		D/W = 1.47

65. Long-Term Interest Rate, Index

$$RLCI = 0.06 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-2} + 0.11 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-3}$$

$$+ 0.16 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-4} + 0.17 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-5}$$

$$+ 0.16 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-6} + 0.13 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-7}$$

$$+ 0.11 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-8} + 0.07 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-9}$$

$$+ 0.04 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-10}$$

66. Mortgage Rate

$$RM = (RC + RNHA)/2$$

67. Change in Official Reserves of Gold and U.S. Dollars

$$RSR = XG(PXG) + XS - MS - MG(PMG) + LTK + STK$$

68. Stock of Houses, 2Q54 - 4Q65

$$\underset{(680.79)}{STH = 0.9997}\ STH_{t-1} + \underset{(2.85)}{0.2240}\ HST + \underset{(5.07)}{0.3723}\ HST_{t-1} + \underset{(4.69)}{0.2750}\ HST_{t-2} + \underset{(4.44)}{0.0961}\ HST_{t-3}$$

$$\underset{(651.6)}{0.9993} \qquad \underset{(2.49)}{0.2015} \qquad \underset{(5.25)}{0.4056} \qquad \underset{(4.99)}{0.3101} \qquad \underset{(4.78)}{0.1100}$$

O.L.S.	$\overline{R}^2 = 0.9998$	T.S.F.	$\overline{R}^2 = 0.9998$
	SEE = 6.62		SEE = 6.66
	COV = 0.15		COV = 0.15
	D/W = 2.02		D/W = 2.02

69. Net Private Short-Term Capital Inflow, 1Q53 - 4Q65

$$
\begin{array}{lllllll}
STK = & 10.54 & -\ 96.26\ Q3 & +\ 3144\ DRS & -\ 9944\ DRSU & +\ 21705\ DRSF & +\ 152.2\ DSK2 \\
 & (.23) & (2.48) & (1.35) & (2.97) & (1.75) & (2.44) \\
 & 34.88 & -\ 86.14 & 3251 & -\ 9729 & 28074 & 118.1 \\
 & (.61) & (2.10) & (1.33) & (2.78) & (2.10) & (1.77)
\end{array}
$$

$$
\begin{array}{ll}
+\ 102.2\ (R03 - RTUS) & -\ 0.2826\ LTK \\
(2.88) & (1.90) \\
42.93 & -\ 0.1210 \\
(.90) & (.55)
\end{array}
$$

O.L.S.	$\overline{R}^2 = 0.382$	T.S.F.	$\overline{R}^2 = 0.336$
	SEE = 112.9		SEE = 116.96
	D/W = 1.72		D/W = 1.78

70. Chartered Banks' Total Loan Authorizations over $100,000, 3Q56 - 4Q65

$$
\begin{array}{lllll}
\dfrac{TA - TA_{t-1}}{TBA} = & -0.00507 & +\ 0.1330\ \dfrac{ELA}{TBA} & +\ 0.0193\ (RPR - RLC) & -\ 0.00790\ (RLC - R03) \\
 & (0.29) & (4.26) & (6.88) & (4.76) \\
 & -0.0143 & 0.1312 & 0.0172 & -\ 0.00659 \\
 & (.73) & (4.01) & (5.45) & (3.19)
\end{array}
$$

$$
\begin{array}{ll}
-\ 0.3567\ \dfrac{TA_{t-1}}{TBA} & +\ 0.00186T \\
(5.58) & (8.49) \\
-\ 0.3008 & 0.00166 \\
(3.81) & (6.11)
\end{array}
$$

O.L.S.	$\overline{R}^2 = 0.729$	T.S.F.	$\overline{R}^2 = 0.721$
	SEE = 0.0033		SEE = 0.0034
	D/W = 1.73		D/W = 1.73

71. Chartered Banks' Total Major Assets

$$TBA = DD + PNPS + DG + CA + OTHL - OTHA$$

72. Chartered Banks' Trended Total Major Assets, 1Q52 - 4Q65

$$
\begin{array}{llllll}
TBAT = & 3611 & +\ 170.2\ T(Q1) & +\ 171.2\ T(Q2) & +\ 172.4\ T(Q3) & +\ 173.3\ T(Q4) \\
 & (16.68) & (34.31) & (35.12) & (35.97) & (36.78)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.968$
SEE = 512.0
COV = 4.29
D/W = .18

73. Corporate Income Tax Accruals, 1Q52 - 4Q65

$$TCA = \underset{(166.8)}{0.9794}\ RPC(PCT) + PLMT$$

$$\underset{(166.6)}{0.9794}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.962	$\bar{R}^2$	= 0.962
SEE	= 17.46	SEE	= 17.46
COV	= 4.6	COV	= 4.60
D/W	= 1.38	D/W	= 1.38

74. Customs Duties, 1Q52 - 4Q65

$$TCUS = \underset{(61.17)}{0.1201}\ PMG(MG) - \underset{(16.20)}{0.0000189}\ [PMG(MG)]^2 + \underset{(10.78)}{0.9876}\ MG(SUR)PMG$$

$$\underset{(60.28)}{0.1209} \quad - \underset{(16.25)}{0.0000195} \quad \underset{(10.74)}{0.9857}$$

$$- \underset{(4.10)}{0.00461}\ Q1\ (MG)PMG$$

$$- \underset{(4.20)}{0.00473}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.963	$\bar{R}^2$	= 0.963
SEE	= 4.69	SEE	= 4.70
COV	= 3.64	COV	= 3.64
D/W	= 1.04	D/W	= 1.05

75. Chartered Banks' Total Deposits

$$TD = \frac{BCD + BCN - ERL}{DCR} - FLO$$

76. Excise Duties, 1Q52 - 4Q65

$$TEX = \underset{(109.2)}{0.02299}\ [CD(PD) + CND(PND)]$$

$$\underset{(109.2)}{0.02299}$$

O.L.S. $\bar{R}^2 = 0.920$	T.S.F. $\bar{R}^2 = 0.920$
SEE = 5.60	SEE = 5.60
COV = 7.04	COV = 7.04
D/W = 1.78	D/W = 1.78

77. Total Indirect Taxes

$$TI = TS + TCUS + TEX + TMIS$$

78. Chartered Banks' Total Loans

$$TL = LB + LBS + LF + LP + LMUN + LPRV + LH + LM$$

79. Total Personal Taxes, 1Q52 - 4Q65

$$\underset{(97.31)}{TP = 1.105} \left(1/3\, AY_{t-1} + 2/3\, AY\right) - \underset{(1.20)}{0.006558}\, Q1 \sum_{i=1}^{i=4} AY_{t-i} + \underset{(7.41)}{0.04106}\, Q2 \sum_{i=2}^{i=5} AY_{t-i}$$

$$\underset{(97.35)}{1.106} \qquad - \underset{(1.24)}{0.006793} \qquad \underset{(7.37)}{0.04081}$$

O.L.S. $\bar{R}^2 = 0.972$	T.S.F. $\bar{R}^2 = 0.972$
SEE = 27.91	SEE = 27.92
COV = 5.84	COV = 5.84
D/W = 1.77	D/W = 1.77

80. Federal Sales Tax, 1Q55 - 4Q65

$$TS = \underset{(74.01)}{0.6326}\, PGNE[CND + CD]\, RSC + \underset{(9.90)}{.5504}\, PGNE[(RSIM)(IME) + .42\,(RSIR)(INRC + IRC)]$$

$$\underset{(73.93)}{0.6329} \qquad \underset{(9.81)}{0.5478}$$

O.L.S. $\bar{R}^2 = 0.943$	T.S.F. $\bar{R}^2 = 0.943$
SEE = 19.30	SEE = 19.30
COV = 7.03	COV = 7.04
D/W = 1.66	D/W = 1.66

81. Unemployment Insurance Benefits, 1Q52 - 4Q65

$$UIB = \underset{(.49)}{-1.657} - \underset{(1.78)}{.5816}\, Q1(S)(WR)CL + \underset{(2.32)}{.8562}\, Q2(S)(WR)CL$$

$$\underset{(1.12)}{-4.104} - \underset{(2.26)}{.7778} \qquad \underset{(2.06)}{.7758}$$

$$- \underset{(2.68)}{1.6359}\, Q3(S)(WR)CL - \underset{(9.72)}{3.5823}\, Q4(S)(WR)CL + \underset{(22.04)}{8.7352}\, (WR)CL$$

$$- \underset{(2.45)}{1.5587} \qquad - \underset{(9.84)}{3.7021} \qquad \underset{(21.05)}{9.0461}$$

O.L.S. $\bar{R}^2 = 0.966$
SEE = 9.80
COV = 11.94
D/W = 1.62

T.S.F. $\bar{R}^2 = 0.965$
SEE = 9.86
COV = 12.02
D/W = 1.64

82. Unemployment Insurance Receipts, 1Q52 - 4Q65

$$\begin{array}{llllll} UIR = & 7.990 & + 10.77\ EMPS & + 6.400\ EMPS(D6) & + 1.321\ Q1(EMPS)S & - 1.703\ Q2(EMPS)S \\ & (2.82) & (12.31) & (20.80) & (3.83) & (4.90) \\ & 7.223 & 11.01 & 6.393 & 1.304 & - 1.729 \\ & (2.53) & (12.45) & (20.78) & (3.78) & (4.97) \end{array}$$

$$\begin{array}{ll} - 0.1407\ Q3(EMPS)S & + 0.0585\ Q4(EMPS)S \\ (0.40) & (0.15) \\ - 0.1770 & 0.0352 \\ (.50) & (0.09) \end{array}$$

O.L.S. $\bar{R}^2 = 0.987$
SEE = 1.79
COV = 3.17
D/W = 2.04

T.S.F. $\bar{R}^2 = 0.987$
SEE = 1.79
COV = 3.17
D/W = 2.04

83. Private Unit Labor Cost

$$ULC = \frac{(WP)(NEPP)(1/12 \sum_{i=0}^{11} (\frac{YGPK}{YGPK + GNW/PGNE})_{t-i})}{YGPK}$$

84. Quarterly Compensation per Employee, Private Sector

WP = (WPH)(HAW)(13)

85. Compensation per Man-Hour, Private Sector, 1Q55 - 4Q65

$$\frac{WPH - WPH_{t-4}}{WPH_{t-4}} \times 100 = \underset{\substack{(2.02) \\ -4.953 \\ (1.98)}}{-4.830} + \underset{\substack{(3.92) \\ 0.9308 \\ (3.68)}}{0.9383} [\tfrac{1}{4} \sum_{i=0}^{3} (\frac{PND - PND_{t-4}}{PND_{t-4}} \times 100)_{t-i}]$$

$$+ \underset{\substack{(4.55) \\ 0.005173 \\ (4.42)}}{0.005172} [\tfrac{1}{4} \sum_{i=0}^{3} (\frac{NU}{NL})_{t-i}]^{-2} + \underset{\substack{(2.41) \\ 90.36 \\ (2.35)}}{88.64} [\tfrac{1}{4} \sum_{i=0}^{3} (\frac{PC - TCA}{YGPK})_{t-i}]$$

$$
\begin{array}{l}
- \underset{(1.63)}{0.2238} \left(\dfrac{WPH_{t-4} - WPH_{t-8}}{WPH_{t-8}} \times 100 \right) \\
- \underset{(1.57)}{0.2208}
\end{array}
$$

O.L.S.	$\overline{R}^2 = 0.655$	T.S.F.	$\overline{R}^2 = 0.655$
	SEE = 1.13		SEE = 1.13
	D/W = 1.76		D/W = 1.77

86. Wages, Salaries and Supplementary Labor Income

$$WSSL = WP(NEPP) + WG(NEPG)$$

87. Exports of Goods, 1Q53 - 4Q65

$$
\begin{array}{llllllll}
XG = & \underset{(3.60)}{1921} & - \underset{(10.27)}{294.8}\ Q1 & - \underset{(3.53)}{83.08}\ Q2 & - \underset{(3.15)}{74.73}\ Q3 & + \underset{(35.47)}{1455}\ AWI & - \underset{(1.89)}{736.2} & \left(Y - XG - \dfrac{XS}{PXS}\right)/YC \\
 & \underset{(3.23)}{2033} & - \underset{(9.39)}{294.5} & - \underset{(3.52)}{83.22} & - \underset{(3.13)}{74.68} & \underset{(35.12)}{1453} & - \underset{(1.47)}{721.2} &
\end{array}
$$

$$
\begin{array}{llll}
- \underset{(4.11)}{331.3} \dfrac{PXG}{PWXG} & - \underset{(4.11)}{289.9} \left(\dfrac{PXG}{PWXG}\right)_{t-1} & - \underset{(4.11)}{248.5} \left(\dfrac{PXG}{PWXG}\right)_{t-2} & - \underset{(4.11)}{207.1} \left(\dfrac{PXG}{PWXG}\right)_{t-3} \\
- \underset{(4.14)}{358.1} & - \underset{(4.14)}{313.3} & - \underset{(4.14)}{268.5} & - \underset{(4.14)}{223.8}
\end{array}
$$

$$
\begin{array}{llll}
- \underset{(4.11)}{165.6} \left(\dfrac{PXG}{PWXG}\right)_{t-4} & - \underset{(4.11)}{124.2} \left(\dfrac{PXG}{PWXG}\right)_{t-5} & - \underset{(4.11)}{82.82} \left(\dfrac{PXG}{PWXG}\right)_{t-6} & - \underset{(4.11)}{41.41} \left(\dfrac{PXG}{PWXG}\right)_{t-7} \\
- \underset{(4.14)}{179.0} & - \underset{(4.14)}{134.3} & - \underset{(4.14)}{89.51} & - \underset{(4.14)}{44.76}
\end{array}
$$

O.L.S.	$\overline{R}^2 = 0.967$	T.S.F.	$\overline{R}^2 = 0.967$
	SEE = 59.97		SEE = 60.05
	COV = 4.31		COV = 4.33
	D/W = 1.33		D/W = 1.33

88. Exports of Services, 1Q52 - 4Q65

$$XS = \underset{(4.41)}{-107.8} - \underset{(8.22)}{97.33}\ Q1 - \underset{(1.58)}{18.66}\ Q2 + \underset{(10.41)}{123.2}\ Q3 + \underset{(22.95)}{487.9}\ AWS$$

O.L.S. $\overline{R}^2 = 0.942$
SEE = 31.31
COV = 7.47
D/W = 1.88

89. Real Domestic Product Less Agriculture

$$Y = \frac{YGNE + SUBS + INTF + DIVF - RES - TI - NRR - YFA + YX}{PGNE}$$

90. Assessed Taxable Income

$$\underset{(6.81)}{YAS = -493.8} + \underset{(71.99)}{0.8153\ YP}$$

O.L.S. $\bar{R}^2 = 0.997$
SEE = 0.324
COV = 1.80
D/W = 1.52

91. Assessed Taxable Income between 0 and $3,000

YAS1 = Y1(YAS)

92. Assessed Taxable Income between $3,000 and $5,000

YAS2 = Y2(YAS)

93. Assessed Taxable Income between $5,000 and $10,000

YAS3 = Y3(YAS)

94. Assessed Taxable Income over $10,000

YAS4 = YAS - YAS1 - YAS2 - YAS3

95. Capacity Real Domestic Product

$$YC = 0.5\ \left(\frac{KME}{KMEY} + \frac{KNR}{KNRY}\right)$$

96. Real Disposable Personal Income

YD = YP - TP - TOP

97. Permanent Real Disposable Income

$$YDP = 0.176 \sum_{i=0}^{i=7} .9^i \left(\frac{YD}{PGNE}\right)_{t-i}$$

98. Gross National Expenditure

YGNE = YGPK(PGNE) + GW + GNW + MP + INVF - RES - GX

99. Private Non-farm Real Gross National Expenditure

$$YGPK = CND + CD + CS + IME + INRC + IRC + INV + XG + \frac{XS}{PXS} - MG - \frac{MS}{PMS}$$

100. Personal Income

$$YP = WSSL + MP - SSPS - UIR + YF + YNFC + YI + DIVC + GINT + CCB - TW - GIM$$
$$+ GTR + UIB + YRES$$

101. Simulated Income - Expenditure Residual

$$YRES = YGNE + DIVF - WSSL - MP - YI - YNFC - IVA - YFA - TI - CCA + SUBS$$
$$- PC - RES$$

A P P E N D I X   C

LIST OF VARIABLES

APPENDIX C

LIST OF VARIABLES
(The 101 endogenous variables of the model are denoted by *)

	ALTM	Total assets of trust and mortgage companies plus total assets less policy loans of 12 insurance companies. Millions. (11240)
	ASST	Government capital assistance to industry. Millions. (11283)
	AWI	World activity index, 1957=1. (9863)
	AWS	World activity index for services, 1957=1. (8202)
*	AY	Personal income tax accruals. Millions (11600)
	BCD	Chartered Banks' Canadian dollar deposits at the Bank of Canada. Millions. (2795)
	BCN	Chartered banks' Canadian cash reserves, Bank of Canada notes. Millions.(399)
	CA	Chartered banks' capital account, shareholders equity. Millions. (11208)
	CCA	Capital consumption allowances and miscellaneous valuation adjustments. Millions. (234)
	CCAC	Capital consumption allowances, corporations. Millions. (3711)
	CCB	Charitable contributions by corporations. Millions. (239)
*	CD	Personal expenditure on durable goods. Millions of 1957 dollars. (141)
*	CFR	Cash flow ratio. The cash flow is the sum of corporate retained earnings (PCRT) and capital consumption allowances (CCA) deflated by the implicit GNE deflator (PGNE). CFR is the ratio of the cash flow to the trend value of the cash flow (CFRT). (11096)
*	CFRT	Trend value of the cash flow. (11310)
*	CL	Claimants on the Unemployment Insurance Fund. Millions of persons. (11247)
*	CLC	Average cost of construction per square foot (including land) on new single detached NHA homes. (11369)
	CMHC	CMHC direct mortgage approvals. Millions (11440)
*	CND	Consumer non-durable expenditure. Millions of 1957 dollars. (140)
*	CS	Personal expenditure on services. Millions of 1957 dollars. (139)
	D5	Dummy; equals 1 from first quarter 1952 to third quarter 1959, zero elsewhere. (11323)

D6 Dummy; equals 1 from fourth quarter 1959, zero elsewhere. (11324)

D7 Dummy; equals 1 from first quarter 1964, zero elsewhere. (11531)

D8 Dummy; equals 1 from first quarter 1961, zero elsewhere. (11459)

DCR Required cash reserve ratio. (11527)

* DD Chartered banks' demand deposits less float. Millions. (699)

DG Chartered banks' Government of Canada deposits. Millions. (386)

* DIVC Dividends paid to Canadians by Canadian companies. Millions. (2406)

* DIVF Dividends paid to non-residents by Canadian companies. Millions. (227)

DLK1 Dummy; equals 1 from third quarter 1963, zero elsewhere. (11108)

DLK4 Dummy; equals 1 in fourth quarter 1965, zero elsewhere. (11109)

DRS First difference of the Canadian price of U.S. dollars. Canadian dollars per U.S. dollar. (5691)

DRSF Defined as DRS from third quarter 1962, zero elsewhere. (11243)

DRSU Defined as DRS from third quarter 1961 to second quarter 1962, zero elsewhere. (11243)

DSK2 Dummy; equals 1 in each quarter of 1965, zero elsewhere. (11244)

DVST Dummy variable for sales tax on building materials; equals 1 from third quarter 1963 to second quarter 1966, zero elsewhere. (11027)

* ELA Chartered banks' more liquid assets (including foreign assets). Millions. (11296)

* EMPS Employed contributors to Unemployment Insurance Fund. Millions of persons. (11246)

ERL Chartered banks' excess legal reserves. Millions. (11297)

FLO Chartered banks' float, estimated net Canadian dollar items in transit. Millions. (11282)

* GBAL Total government national accounts surplus (if positive) or deficit (if negative). Millions. (1385)

GIM Total investment income, all levels of government. Millions. (1361)

GINT Interest on the public debt. Millions. (1375)

GNW Government non-wage expenditures. Millions. (11068)

GTR Government transfer payments to persons, excluding interest on the public debt and unemployment insurance benefits. Millions. (11287)

* GW Government wage payments, public administration. Millions. (11067)

GWI Government wage payments, institutional sector. Millions. (11379)

GX Correction for seasonality in quarterly series for government wage and non-wage expenditure. Millions. (11601)

* H Stock of non-farm inventories. Millions of 1957 dollars. (11636)

* HAW Average weekly hours worked by paid non-agricultural workers. (1205)

* HAWT Trend value of HAW. (11414)

HH Number of families in Canada. Thousands. (3054)

* HSL Inventory stock/sales ratio. (11637)

* HSLT Trend value of inventory stock/sales ratio. (11638)

* HST Total number of dwelling starts. Thousands. (3064)

* IME Investment in machinery and equipment. Millions of 1957 dollars. (11306)

* INRC Investment in non-residential construction. Millions of 1957 dollars. (11307)

* INS Level of enrolment in Unemployment Insurance Fund. Millions of persons. (11257)

INTF Interest payments to non-residents. Millions. (11651)

* INV Change in non-farm business inventories. Millions of 1957 dollars. (150)

INVF Farm inventories and grain in commercial channels. Millions. (219)

* IRC Investment in residential construction. Millions of 1957 dollars. (145)

IVA Inventory valuation adjustment. Millions. (231)

* KME Stock of machinery and equipment. Millions of 1957 dollars. (11309)

* KMED Desired stock of machinery and equipment. Millions of 1957 dollars. (11316)

* KMEG Gap between desired and actual stock of machinery and equipment. Millions of 1957 dollars. (11317)

* KMEY Trend value of machinery and equipment capital-output ratio. (11315)

* KNR Stock of non-residential construction. Millions of 1957 dollars. (11314)

* KNRD Desired stock of non-residential construction. Millions of 1957 dollars. (11313)

* KNRG Gap between desired and actual stock of non-residential structures. Millions of 1957 dollars. (11090)

* KNRY Trend value of non-residential construction capital-output ratio. (11311)

L Index of land costs on new single detached NHA homes. 1957 = 100. (11372)

* LB Chartered banks' business loans over $100,000. Millions. (11271)

LBS Chartered banks' business loans under $100,000. Millions. (11272)

LF Chartered banks' loans to instalment finance companies. Millions. (693)

LH Chartered banks' insured mortgages. Millions. (3993)

* LINE Estimated trend value of ln INRC. (11449)

* LIRE Estimated trend value of ln IRC. (11450)

LM Chartered banks' farm, CSB, grain dealer and institution loans. Millions. (11290)

LMUN Chartered banks' loans to municipalities. Millions. (692)

* LP Chartered banks' loans to persons. Millions. (11042)

LPRV Chartered banks' loans to provinces. Millions. (691)

* LTK Net long term capital inflow. Millions of 1957 dollars. (9143)

* MG Imports of goods. Millions of 1957 dollars. (9147)

MLTM Weighted sum of total mortgage holdings of 12 life insurance, trust and mortgage companies. Millions. (11645)

MP Military pay and allowances. Millions. (225)

* MS Imports of services. Millions. (9149)

N03 Proportion of total persons taxable with taxable income between 0 and $3,000. (11302)

N35 Proportion of total persons taxable with taxable incomes between $3,000 and $5,000. (11303)

	N51	Proportion of total persons taxable with taxable income between $5,000 and $10,000. (11304)
*	NEP	Total number of paid workers. Millions of persons. (11604)
	NEPG	Paid workers, public administration and defense. Millions of persons. (11060)
*	NEPP	Paid workers, private sector. Millions of persons. (11059)
*	NEUP	Employed, unpaid workers. Millions of persons. (11062)
*	NL	Total civilian labor force. Millions of persons. (11141)
	NRR	Income received from non-residents. Millions. (11322)
*	NT	Total number of persons taxable, calculated. Millions of persons. (11544)
*	NT03	Number of persons taxable with taxable incomes between 0 and $3,000, calculated. Millions of persons. (11545)
*	NT35	Number of persons taxable with taxable incomes between $3,000 and $5,000, calculated. Millions of persons. (11546)
*	NT51	Number of persons taxable with taxable incomes between $5,000 and $10,000, calculated. Millions of persons. (11547)
*	NT10	Number of persons taxable with taxable incomes over $10,000. Millions of persons. (11548)
*	NU	Total unemployed. Millions of persons. (11063)
	OCS	Chartered banks' other Canadian securities. Millions. (3950)
	OTHA	Chartered banks' all other assets. Millions. (11209)
	OTHL	Chartered banks' all other liabilities. Millions. (11038)
*	PC	Corporation profits before taxes and before dividends paid to non-residents. Millions. (226)
*	PCRT	Undistributed corporation profits. Millions. (1393)
*	PCT	Taxable corporate profits. Millions. (11624)
*	PD	Implicit price index of consumer durable expenditure. 1957 = 1. (11384)
*	PGNE	Deflator of Gross National Expenditure less government less farm inventories. 1957 = 1. (9153)
*	PH	Index of housing prices. 1957 = 100. (11070)
	PLMT	Provincial logging and mining taxes. Millions. (11626)

	PMB	Net new issues of provincial and municipal securities. Millions. (11465)
	PMG	Implicit price index of goods imports. 1957 = 1. (9145)
	PMS	Implicit price index of service imports. 1957 = 1. (9151)
*	PND	Implicit price index of consumer non-durable expenditure. 1957 = 1. (11423)
*	PNPS	Chartered banks' personal savings and non-personal term and notice deposits. Millions. (11664)
	POP	Civilian, non-institutional population. Millions of persons. (11308)
	POPT	Total Canadian population. Millions of persons. (3032)
	PWXG	Price index of world exports in Canadian dollars. 1957 = 1. (9154)
*	PXG	Implicit price index of goods exports. 1957 = 1. (9144)
*	PXS	Implicit price index of service exports. 1957 = 1. (9150)
	Q1	First quarter seasonal dummy. 1 in Q1, 0 otherwise. (11073)
	Q2	Second quarter seasonal dummy. 1 in Q2, 0 otherwise. (11074)
	Q3	Third quarter seasonal dummy. 1 in Q3, 0 otherwise. (11075)
	Q4	Fourth quarter seasonal dummy. 1 in Q4, 0 otherwise. (11076)
*	R03	Average yield on short term Government of Canada bonds, zero to three years. (1365)
*	RC	Conventional mortgage rate. (1096)
	RDC	Rate of dividend tax credit. (11006)
	RES	Residual error of estimate. Millions. (235)
*	RLC	Average yield on long term Government of Canada bonds, ten to fifteen years. (2764)
*	RLCI	12 quarter moving index of RLC. (11091)
	RLUS	United States corporate bond yield. (11466)
*	RM	Mortgage rate. (11318)
	RNHA	Maximum NHA mortgage rate. (245)

RPC Weighted marginal rate of corporate income tax. (11007)

RPR Chartered banks' prime loan rate. (397)

RSC Sales tax rate on consumption goods. (11025)

RSIM Sales tax rate on machinery, equipment. (11620)

RSIR Sales tax rate on non-residential construction. (11621)

* RSR Change in official foreign exchange, reserves, in millions of Canadian \$. (11289)

RTUS Market yield on United States Government three month bills. (4255)

RW1 Weighted tax rate for 0 to \$3,000 class. (11019)

RW2 Weighted tax rate for \$3,000 to \$5,000 class. (11020)

RW3 Weighted tax rate for \$5,000 to \$10,000 class. (11021)

RW4 Weighted tax rate for over \$10,000 class. (11022)

S Dummy; equals 1 from first quarter 1959 to fourth quarter 1967, zero elsewhere. (11327)

S2 Four quarter moving variance of holding period yield on 5 year rate. (2702)

SP Number of persons going to school. Millions of persons. (11396)

SSPS Social security and pension contributions net of employer and employee payments into unemployment insurance fund. (11285)

* STH Stock of houses. Thousands of units. (3057)

* STK Net private short term capital inflow. Millions. (9139)

SUBS Total subsidies from all levels of government. Millions. (1378)

SUR Amount of surcharge that would have been collected had the 1961 volume of imports been maintained through the surcharge period, 2Q 1962 - 4Q 1963. (11010)

T Time trend; equals 1 in first quarter 1947. (11142)

T1 Time trend; equals 6 in first quarter 1952 increasing to third quarter 1959, zero elsewhere. (11325)

T2 Time trend; equals 1 in first quarter 1959 increasing to fourth quarter 1967, zero elsewhere. (11326)

	T3	Time trend; a step function, equals 1 in each quarter of 1950, two in 1951, etc. (11625)
*	TA	Chartered banks' total business loan authorizations outstanding over $100,000. Millions. (11273)
*	TBA	Chartered banks' total major assets. Millions. (383)
*	TBAT	Time trend of chartered banks' total major assets. Millions. (11572)
*	TCA	Corporate income tax accruals. Millions. (1352)
*	TCUS	Customs import duties. Millions. (2157)
*	TD	Chartered banks' total Canadian deposits including government deposits. Millions. (384)
*	TEX	Excise duties. Millions. (2158)
*	TI	Total indirect taxes. Millions. (1358)
*	TL	Chartered banks' total loans. Millions. (11291)
	TMIS	Indirect taxes other than federal sales, customs and excise duties. Millions. (11288)
	TOP	Total personal direct taxes other than personal income taxes. Millions. (11321)
*	TP	Personal income tax collections. Millions. (11560)
*	TS	Federal sales tax collections. Millions. (11270)
	TW	Federal with-holding taxes. Millions.(1357)
*	UIB	Federal transfers to persons, unemployment insurance benefits. Millions. (2167)
*	UIR	Employer and employee contributions to federal unemployment insurance. Millions. (2178)
*	ULC	Private unit labour costs. (11649)
	VC	Bank of Canada notes at Chartered banks. Millions. (389)
	WC	Average hourly earnings of hourly rated construction workers. (2486)
	WG	Average quarterly wage in the government sector. (11057)
*	WP	Average quarterly wage in the private sector. (11056)

*	WPH	Average hourly wage in the private sector. (11425)
	WR	Weighted maximum rate of unemployment insurance payments. (11248)
*	WSSL	Wages, salaries and supplementary labor income. Millions (224)
	WW	Dummy winter works variable; equals one in fourth quarter 1963 and each fourth quarter thereafter, zero elsewhere. (11320)
*	XG	Exports of goods. Millions of 1957 dollars. (9146)
*	XS	Exports of services. Millions. (9148)
*	Y	Real domestic product less agriculture. Millions of 1957 dollars. (11312)
	Y1	Proportion of total assessed income in 0 to $3,000 class. (11393)
	Y2	Proportion of total assessed income in $3,000 to $5,000 class. (11394)
	Y3	Proportion of total assessed income in $5,000 to $10,000 class. (11395)
*	YAS	Total assessed income, calculated. Millions. (11550)
*	YAS1	Total assessed income in 0 to $3,000 class. Millions. (11551)
*	YAS2	Total assessed income in $3,000 to $5,000 class. Millions. (11552)
*	YAS3	Total assessed income in $5,000 to $10,000 class. Millions. (11553)
*	YAS4	Total assessed income in over $10,000 class. Millions. (11554)
*	YC	Capacity real domestic product less agriculture. Millions of 1957 dollars. (11446)
*	YD	Personal disposable income. Millions. (1398)
*	YDP	Permanent real disposable income. Millions. (3052)
	YEX1	Average exemptions claimed by those taxpayers with assessed incomes between 0 and $3,000. Dollars. (11556)
	YEX2	Average exemptions claimed by those taxpayers with assessed incomes between $3,000 and $5,000. Dollars. (11557)
	YEX3	Average exemptions claimed by those taxpayers with assessed incomes between $5,000 and $10,000. Dollars. (11558)
	YEX4	Average exemptions claimed by those taxpayers with assessed incomes over $10,000. Dollars. (11559)

	YF	Income of farm operators excluding accruals. Millions. (11005)
	YFA	Accrued net income of farm operators from farm production. Millions. (229)
*	YGNE	Gross national expenditure at market prices. Millions. (223)
*	YGPK	Gross National Expenditure less government and less farm inventories. Millions of 1957 dollar. (11069)
	YI	Rent, interest and miscellaneous investment income. Millions. (228)
	YNFC	Net income of non-farm unincorporated business. Millions. (230)
*	YP	Personal income. Millions. (240)
*	YRES	Simulation residual; defined to be zero over estimation period but equilibrating income and expenditure sides of national accounts under simulation. (11528)
	YX	Real domestic product less agriculture residual; defined to reconcile the National Accounts definition with the figures published by the DBS in index form. Millions. (11650)

RÉSUMÉ

RDX1 est un modèle trimestriel de l'économie canadienne; il s'agit d'un modèle agrégé de dimension intermédiaire. Il comprend 101 équations, dont 50 relations stochastiques de comportement et 51 relations techniques et identités. Comme ce modèle a été conçu dans le but d'en arriver finalement à une meilleure connaissance des effets des mesures prises en matière de politique monétaire et fiscale, nous avons tenté d'y incorporer, d'une manière explicite, les instruments de la politique économique tels que les taux des impôts et les réserves bancaires. Nous avons accordé une attention particulière aux secteurs financier et gouvernemental; dans ces secteurs, en effet, les instruments de politique économique ont un impact direct et immédiat sur les variables qui influencent à leur tour, directement ou indirectement, les diverses composantes de la demande ou de l'offre globale, ou des deux.

La structure fondamentale de ce modèle est semblable à celle des modèles macroéconomiques existants dans lesquels l'économie d'un pays est présentée comme un processus dynamique comportant la formation successive du revenu, de la demande globale, de la production, des salaires et des prix. Ce modèle tente, cependant, de saisir certains traits spécifiques de l'économie canadienne. La plus remarquable et la plus importante de ces caractéristiques est l'extrême sensibilité de l'économie canadienne à des influences économiques ayant leur origine à l'étranger, notamment aux États-Unis. Ce caractère ouvert de l'économie canadienne affecte aussi bien le secteur réel que financier. Aussi, la production, les prix et les taux d'intérêt à l'étranger apparaissent-ils comme variables importantes dans plusieurs secteurs du modèle. Comme on doit s'y attendre, cette ouverture exerce une influence marquée (en raison de nombreuses fuites) sur la nature des objectifs économiques qui sont à la portée de la politique économique canadienne. La structure du modèle est centrée sur la détermination (compte tenu des contraintes résultant d'influences économiques externes) des dépenses brutes et de la production du secteur privé, en termes réels, ainsi que de l'emploi et des prix pertinents. Etant donné que l'ensemble du secteur public (aussi

bien que l'investissement en stocks du secteur agricole) est traité en dollars courants, notre principale variable-prix est l'indice implicite des prix de la dépense réelle du secteur privé.

Notre approche et notre façon de procéder lorsqu'il s'est agi de construire ce modèle ont été quelque peu différentes de celles qu'ont adoptées ceux qui ont construit jusqu'ici des modèles agrégés de quelque importance. Au lieu de rechercher la "perfection" dans la spécification de chacune des relations utilisées, en vérifiant, par toute une série de tests isolés, la validité de différentes théories de la consommation, de l'investissement, de la détermination des salaires, etc., nous avons préféré concentrer nos efforts sur l'analyse des propriétés dynamiques d'un système complet, même si sa formulation n'était pas des plus satisfaisantes dans certains cas. Nous avons jugé que, si nous pouvions examiner le plus tôt possible les interactions et les rétroactions des divers secteurs du modèle, cette étude nous fournirait des indications très utiles à l'amélioration ultérieure de sa spécification; elle nous permettrait en outre d'identifier clairement, avant que nous n'épuisions notre énergie et nos ressources, les secteurs (ou les paramètres) qui exigeraient une attention particulière. Nous présentons dans la présente étude l'ensemble des équations structurelles qui constituent le modèle RDX1. Certaines de ces équations furent choisies avant que nous n'ayons procédé à des expériences dynamiques avec un modèle complet, alors que d'autres ont été modifiées à la lumière de notre première série d'expériences de simulation. Dans une deuxième étude portant sur le modèle RDX1, nous en exposerons les propriétés dynamiques, telles que révélées par une série d'expériences de simulation.

Nous devons préciser, enfin, que nous désirions présenter la documentation relative au modèle sous une forme qui puisse susciter des commentaires, des études critiques, des tests ou d'autres emplois du modèle. Ce souci nous a conduits à concevoir notre système de façon à pouvoir publier non seulement le modèle, mais aussi les programmes et les données de base (y compris la procédure d'estimation et de simulation), le tout sous une forme accessible aux ordinateurs et d'un maniement facile. La description de l'ensemble du système fera l'objet d'un manuel que publiera prochainement la Banque du Canada.

No. 4

BANK OF CANADA
STAFF RESEARCH STUDIES

GOVERNMENT SECTOR EQUATIONS FOR MACROECONOMIC MODELS

1969

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PREFACE

In this study we discuss the various ways of building government sectors of macroeconomic models, present the analysis underlying the government sector equations in the first version of the Bank of Canada's aggregate quarterly model, RDX1, and provide some basis for constructing government sectors for other macro-models being built for various purposes. The government sector designed for RDX1 may be too detailed for macro-models not intended for the analysis of alternative monetary and fiscal policies. However, despite the extensive detail in the government sector of RDX1 and in this paper, we treat numerous items inadequately——particularly expenditures and changes in asset and liability accounts. In view of the many facets of government activity to be modelled, we have had to establish priorities and deal first with the topics that seemed to promise the greatest return for our efforts. We set out in the first section of the paper some of the criteria used in deciding how to allocate our efforts during the first years of research. It is our hope that the range of experiments to date is wide enough to provide some guidance for economists designing government sectors for other macro-models. Since this is one of our main goals, we shall be explicit about the definitions of variables and the sources and details of our data. We have also developed an indexing system, intended to cover the various components of the Canadian federal, provincial, and municipal government sectors. This index is printed just after the data appendix.

As we are still in the midst of our research this paper is essentially a progress report on what we have found so far. Fairly complete sets of equations have been developed for the major revenues and transfer payments of the federal government and for the revenues of the provincial governments. We are gradually working our way down our list of priorities, so that RDX2 ought to contain a reasonably full treatment of provincial and municipal revenues,

some expenditure equations for all levels of government, and equations explaining certain major changes in federal government asset and liability accounts.

This study is divided into four parts. Part 1 is an outline of the theoretical and practical problems involved in constructing a government sector model. Part 2 contains federal government tax equations. In Part 3 we present results of work related to the principal federal government transfer payments, and Part 4 contains equations for major provincial revenues. Although this study is very much a joint effort, some division of labour occurred during the course of the research. Helliwell was responsible for Part 1 and for the specification of the revenue equations. Stephenson, Evans, and Jarrett were mainly responsible for Parts 2, 3, and 4, respectively. Gorbet has recalculated some of the models, and extensively redrafted certain parts of the paper to make them dovetail more smoothly with the RDX1 fiscal sector.

PRÉFACE

Cette étude comporte, en plus d'un exposé des différentes façons de procéder à la construction du secteur public dans les modèles macroéconomiques, l'analyse des principes fondamentaux qui ont servi à établir les équations de ce secteur dans la 1ère version du modèle trimestriel élaboré par la Banque du Canada—le RDX1. Elle offre une certaine base susceptible de servir à la construction du secteur public dans d'autres modèles macroéconomiques destinés à des emplois différents. Le secteur public conçu pour le RDX1 est probablement trop détaillé pour des modèles qu'on n'envisagerait par d'utiliser pour analyser les incidences possibles de différentes politiques monétaires et fiscales. Cependant, malgré la variété des détails incorporés dans le secteur public du RDX1 et dont fait état la présente étude, plusieurs composantes n'ont pas été suffisamment analysées, notamment les dépenses et les variations des éléments de l'actif et du passif. C'est qu'en raison des aspects multiples de l'activité gouvernementale dont notre modèle devait tenir compte, nous avons dû établir un ordre de priorité et commencer par les domaines où nos efforts promettaient d'être le plus fructueux.

Dans la première section de la présente étude, nous avons exposé quelques-uns des critères que nous avons adoptés dans la répartition de nos efforts au cours de nos premières années de recherche. Nous espérons que les expériences auxquelles nous avons procédé jusqu'ici ont été suffisamment variées pour servir de guide, dans une certaine mesure, aux économistes qui auront à élaborer les équations du secteur public dans d'autres modèles macroéconomiques. C'est d'ailleurs un de nos principaux objectifs et nous serons très explicites au sujet des définitions de nos variables et de la source et des détails de nos données. Nous avons en outre développé un système d'indexation susceptible d'englober les divers éléments du secteur public, aux niveaux fédéral,

provincial et municipal. L'index est reproduit à la suite des données publiées en annexe.

Comme nous n'avons pas encore terminé nos recherches, la présente étude est essentiellement un rapport provisoire sur les résultats obtenus jusqu'à présent. Nous avons mis au point des séries assez complètes d'équations représentant les principales catégories de revenus et de paiements de transfert du gouvernement fédéral et les revenus des gouvernements provinciaux. En suivant graduellement l'ordre de priorité que nous avons établi, nous devrions aboutir, avec le modèle RDX2, à une présentation relativement détaillée des revenus provinciaux et municipaux, à certaines équations des dépenses publiques aux niveaux fédéral, provincial et municipal et à des équations expliquant les plus importants changements enregistrés aux comptes de l'actif et du passif du gouvernement fédéral.

Cette étude est divisée en quatre parties. La 1ère partie est un exposé des problèmes théoriques et pratiques que comporte la construction d'un modèle du secteur public. La 2ième partie présente les équations des impôts du gouvernement fédéral et la 3ième partie, les résultats des travaux relatifs aux principaux paiements de transfert du gouvernement fédéral; enfin, la 4ième partie présente des équations des principales recettes des provinces. Bien que cette étude soit essentiellement le fruit d'un effort collectif, une certaine répartition des tâches s'est imposée au cours des travaux de recherche. M. Helliwell a été chargé de la 1ère partie et de la mise en équations des revenus. MM. Stephenson, Evans et Jarrett ont été respectivement chargés des 2e, 3e et 4e parties. Enfin M. Gorbet a vérifié les calculs d'un certain nombre de modèles et a revisé, dans une large mesure, le texte de certaines parties de l'étude, de façon à les harmoniser davantage avec le secteur fiscal du RDX1.

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PART 1 OUTLINE OF THE GOVERNMENT SECTOR

In this part of the paper we outline the necessary features of the government sector of a policy-oriented model of the economy, and discuss some of the problems involved in specifying the necessary equations and establishing the appropriate links between the government and non-government sectors.

We should presumably be working towards econometric models that specify the expenditures and related patterns of financing of each aggregate sector of the economy. Even if the present flow-of-funds data do not allow the adequate specification of changes in the financial asset and liability accounts of the private sector, we can make the necessary improvements in the specification of the public sector transactions. This ought to be done for the national government at least, since the links between government expenditure, taxation, and the pattern of government financing must be established before a model can take adequate account of the constraints these links place on the choice of monetary, fiscal and debt management policies.

In this part of the paper we will show, in three stages, how appropriate government submodels may be developed and integrated with a variety of macro-models used for different purposes. Section A contains an outline of the structure of a government submodel suitable for policy analysis, section B a discussion of the specification and estimation of the various types of equations required, and section C a consideration of how various descriptions of the government sector can be built up and linked to the relevant macro-models. No single specification of the government sector is right for all policy models, and in section C we indicate how the government submodel should be built up for different sorts of policy analysis.

A. The Structure of the Government Sector

The government sector model must reflect government income and expenditure as well as the pattern of government finance and

the necessary relationships between the two must be made explicit. For a policy model this complete explanation of government income, expenditure, and debt management behaviour must be given separately for each autonomous government unit. There should be a distinct government submodel for each level of government, since in Canada each level has different expenditure obligations, income sources and policy instruments within its control.

The simplest way of accounting for the interdependence between income-expenditure flows and changes in government asset and liability accounts is to set up a source- and application-of-funds statement. The analytic distinction between this procedure and the one usually adopted in econometric models should be made clear. This is done by putting the major national accounts income-expenditure items together at the beginning of the source and application statement. The usual econometric model sets out to explain all the important expenditure and income items in the *National Accounts*,[1] so that any item in the source and application statement below the national accounts balance is not included.

If the balance sheet identity is to hold exactly (with income minus expenditure plus changes in asset and liability accounts equal to zero) then all the elements must have the same dimensions. The most obvious numéraire is current dollars. However, some of the expenditure equations might better be expressed in constant rather than current dollars. In the abstract, assuming we could get appropriate parameter estimates for the chosen equations, we can describe all expenditure decisions as relating to current rather than constant dollars.[2] We assume, at this stage, that it is appropriate to express all relevant government income, expenditure, and changes in balance sheet accounts in terms of current

[1]*National Accounts, Income and Expenditure* issued quarterly and annually by the Dominion Bureau of Statistics, catalogue nos. 13-001 and 13-201, respectively.

[2]If G is the (current-dollar) expenditure, X an (constant-dollar) activity measure indicating the requirement for government expenditure, and P the price level, the equation can equivalently be expressed as $G = f_1\ (XP)$ or $G/P = f_2\ (X)$. Only when it comes to estimation of parameters is there a difference between these two formulations. The choice here is between normalization rules, and theory should tell us which rule is preferable. See pp. 9-10 for further discussion.

dollars. In the next section we discuss the estimation problems that must be dealt with if the use of current-dollar magnitudes is to be strictly appropriate. The general procedure followed in the construction of RDX1 was to express all government revenue and expenditure in current dollars, all non-government expenditure in constant dollars, and all non-government income items in current dollars.

The operations of a government sector are outlined in Table 1. Items chosen for this table are the major elements in the operations of the Canadian federal government, although the statement would have the same form for any other level of government. However, in practice, only federal government securities are purchased by the central bank in the course of its monetary policy transactions. It is therefore convenient for analytical purposes to consolidate the operations of the central bank with those of the federal government, and to regard all cash and deposits at the central bank (net of federal government deposits) as part of the federal government debt. Thus we can show in Table 1 all the basic elements of government income, expenditure and financial management.

The items included in part B of Table 1 are not usually brought into econometric models. Among other things, these items reflect changes in foreign exchange reserves and other federal government purchases and sales of foreign assets (all encompassed in item 2-3-2-1). Item 2-3-2-2 shows the net transfers on loan or investment accounts to crown corporations. The largest elements here are the transfers to Central Mortgage and Housing Corporation and to the Farm Credit Corporation. Item 2-3-2-6 refers only to the corporation income tax since it is the one tax that appears in the *National Accounts* on an accrual basis,[3] all others being recorded in the *National Accounts* at the time the collections are received. The various categories of item 2-3-3 measure changes in the mix and total size of the government debt. The sums of the two columns of Table 1, source and use of funds, must be equal. It is this constraint that is ignored when only

[3]One can also consider the withholding tax to be on an accrual basis because of the way it is recorded in the *National Accounts*. See footnote 10, p. 16.

Table 1

OUTLINE OF THE OPERATIONS OF A GOVERNMENT SECTOR*

A. Income and Expenditure Flows on a National Accounts Basis

Index Code No.**		Source	Use
2-1-1	Direct taxes, persons (approx. 96% income tax)	2,716	
2-1-2	Corporation income tax accruals	1,675	
2-1-3	Non-Resident withholding tax	168	
2-1-4	Indirect taxes	3,252	
2-1-5	Investment income	630	
2-1-6	Insurance and pension accounts	618	
2-2-1	Goods and services, defence		1,559
2-2-2	Goods and services, non-defence		1,734
2-2-3	Transfers to persons		2,312
2-2-4	Interest on the federal public debt		1,052
2-2-5	Transfers to business and agriculture		343
2-2-6	Transfers to other levels of government		1,434
	Total revenues and expenditures	9,059	8,434

B. Net Changes in Asset and Liability Accounts

		Source	Use
2-3-2-1	Federal government claims on non-residents		127
2-3-2-2	Funds advanced to government enterprises and agencies		657
2-3-2-6	Corporation income taxes accrued but not collected	40	
2-3-2-3, 4, 5, 7	Miscellaneous asset and liability accounts	415	
2-3-3	Government debt outstanding, excluding amounts held by government accounts and the Bank of Canada:		
	Canada Savings Bonds		
	Treasury bills		
	Bonds with term to maturity:		
	less than 2 years		
	2 to 5 years		196
	5 to 10 years		
	Over 10 years		
	Demand liabilities of the Bank of Canada (all currency and central bank deposits held outside the federal government)		
2-3-4	Federal government cash balances at chartered banks and Quebec savings banks***		100
	Total sources and uses	9,514	9,514

* This table is based on the 1965 operations of the Canadian federal government; figures are in millions of dollars.

** These code numbers are used throughout our government sector research, and are based on a classification scheme outlined in the government sector index located at the end of this paper.

*** On November 10, 1969 Banque Populaire, formerly Banque d'Économie de Québec (a Quebec savings bank), commenced operations as a chartered bank. Thus The Montreal City and District Savings Bank is now the only Quebec savings bank still in existence.

the national accounts portion of the government sector is included in econometric models. The interdependence of monetary and fiscal policies is here made quite explicit. Government income-expenditure decisions, government lending, and foreign exchange operations jointly determine the total change in government debt outstanding.

In this context it is clear that monetary policy and debt management decisions are logically interdependent, because once the government income-expenditure decisions are taken, the only policy decision left is how to alter the term structure of the federal debt——the monetary base (currency and chartered bank deposits at the central bank) being treated as the non-interest-bearing portion of that debt——so as to achieve the desired credit conditions. Changes in the size of the monetary base are likely to be the key element of the policy decision, since switching government borrowing from cash to interest-bearing debt, or vice versa, is likely to influence behaviour outside the federal government sector more profoundly than changes in the term structure of the interest-bearing debt.

B. Specification of the Equations

The specification of the equations of the government sector must show explicitly each of the instrument variables that might be altered for policy reasons. Ideally, the equations in the other sectors of a macro-model would be specified in such a way that the same policy instruments would be included. Thus estimates of the expenditure effects of all the various policy changes could be provided. These specification problems lie outside the government sector itself, since the government sector equations show only the determination of the various items listed in Table 1. Here we shall consider some of the problems to be faced in specifying equations for tax receipts, government expenditures, transfer payments, and decisions concerning financing.

When determining which government sector equations to include in a macro-model, or indeed when designing a research strategy for building models of the government sector, it is necessary to establish some ground rules. The criteria we have employed when deciding which items to model first were roughly as follows:

(1) Each explained revenue, expenditure, or asset change should have a structure that can be modelled precisely.

(2) Each explained item should have substantial size and variance.

(3) Each explained item should depend directly on the levels of other variables determined endogenously within a macro-model.

(4) Each explained item should depend on rates or other parameters that have been or might be altered for policy purposes.

The first two criteria are concerned with whether or not an item is worth modelling at all, while the last two are concerned with the requirements of the macro-model our research is intended to service.

In the government sector index at the end of the paper we indicate which items have been modelled and included in this paper and which items have been left for further research. The selection reflects our application of the above priorities. We explain in the following pages some of the factors that influenced these choices.

1. Tax Equations

There are two different approaches to tax equations. The most common procedure is to find one variable or several having significant covariation with the tax receipt, and simply regress the tax receipts series thereon. (See Ando, Brown and Adams [1].) A slight modification of this procedure is to choose a single variable representing the tax base, and then use simple division to find the average tax rate. (See Canadian annual models by Brown [2] and May [5].) An alternative approach is to reject a simple equation that forecasts well in favour of one embodying the essential complexities of the tax structure. Although these more complex equations may be no better for the purposes of short-term forecasting assuming an unchanged tax structure, they have obvious advantages if alternative taxation policies are to be assessed.

The specification of the relevant equations is refreshingly different from the specification of the more usual types of equations in an econometric model. In many behavioural equations the lack of a priori knowledge about the formation of expectations and the lag structure of response makes it almost impossible to choose amongst a number of alternative structural equations. What a relief it is to turn occasionally to a tax equation, where the relevant behaviour is laid out explicitly (although not always clearly) in the tax statutes. The tax law and associated regulations specify both the tax base and the tax rates. If appropriate data were available, one would just construct a tax series by multiplying an appropriate tax base series by the relevant tax rates. Econometric testing would only provide a check to ensure that the sums had been done right. As might be expected, the available data are seldom defined in a manner consistent with the tax law, so that a multitude of fine points (and even some basic features) have to be built into the equations with the aid of the economist's (necessarily) imaginative choice of proxy variables. Since the tax law is quite specific about the rates that are supposed to apply and about the time at which payment must be made, there are very clear (and harsh) criteria for judging the success of a specification. If a tax receipts series is regressed on another series selected and scaled to represent the actual tax base, the estimated coefficient must equal the statutory tax rate——or else! The requirement that coefficients should have specified values if an equation is to be satisfactory means that the equation can be used to derive information about the relationship between the actual tax base and other economic variables. Perhaps this relationship will involve a lot of unravelling, because the data may be unsatisfactory in several ways and the tax structure itself may be quite complex.

An example might help to indicate the kind of approach being advocated. The personal income tax has a number of policy parameters used for stabilization purposes, to increase the supply of effort, or to improve the distribution of income. The important features include basic personal exemptions, dependents' allowances, special allowances (such as the dividend tax credit), and the height and shape of the rate schedule. Some people pay taxes through deductions at source, others on an instalment basis. Different types of income fluctuate differently and make up different fractions of the total income in each income group. To make mat-

ters even worse, there are fluctuations in the proportion of total income assessed for tax purposes, in the proportion of allowances and exemptions actually offset against income, and, of course, in the number of taxpayers in each income group. If all these features are to be included in the model no shortcut is possible. Once such a model is working satisfactorily, however, it allows the consequences of different tax structures to be assessed very quickly. Each of the important features of a tax structure appears explicitly and one can thus assess the pattern of tax receipts under alternative assumptions about the level of aggregate income, or about the tax structure itself.

A multi-equation model may be necessary to depict adequately the personal income tax, but for many purposes a less detailed model is to be preferred. Alternative versions of the model should be available to provide just that amount of detail required for analysis of the question at hand.

In all cases the explanatory variables used in the tax equations should be policy variables, exogenous aspects of economic or demographic structures, or variables explained elsewhere in the model. Since the expenditure equations in the private sector of most models are in real terms (constant dollars), it is not appropriate to use simply the current-dollar expenditure series as an independent variable in the tax equations. The procedure we recommend is the construction of a new variable—the product of two variables explained in the private sector. The exact two to be used will depend upon the structure of the model, but the principle is simple: obtain a current-dollar approximation by finding the product of a constant-dollar expenditure series and the most relevant price series explained in the model.

Most taxes are less complex than the personal income tax and may be modelled more simply, but the basic modelling procedure followed should be the same. Each equation should be an accurate representation of the tax structure, so that the effects of alternative values of the tax parameters may be quickly assessed.

2. Expenditure Equations

People with experience of government budgeting often suggest that economists are too quick to assume that government expenditure can be handily used to adjust the level of aggregate demand. The object of the government expenditure equations is to indicate the extent to which changes in particular government expenditures have been related to economic variables, political events, and economic policy. There is no chance here of duplicating the closely-knit analytic structure of the tax equations. All that the estimated equations can tell us (even assuming that the appropriate economic, political, and policy variables have been included) is how the expenditure has varied in the past in relation to these variables. Suppose, for example, that spending on highways is closely related to the number of registered vehicles and to nothing else. The relationship then would suggest that highway spending has not in the past been varied countercyclically for policy reasons, leaving open the question of how feasible it would be to make such variations in the future. This close relationship may have existed either because the budget makers felt constrained to keep expenditure closely in line with some measure of need, or because they simply did not wish to make countercyclical variations in expenditures. Thus government expenditure equations are largely forecasting equations, useful as a means of indicating what expenditure is likely to be if policy is not changed. Alternative policies can be conveniently assessed only when they are specific about the proposed relationships between future expenditure and other variables appearing in the model.

What estimation problems arise from the decision to have the government expenditure equations expressed in current dollars? Using the procedure suggested in the last section, one can derive current-dollar approximations for any independent variables in the government expenditure equations. A problem would then arise only if the extra weighting attached to observations in the periods of high prices gave rise to inappropriate estimates. If linear regression in the untransformed current-dollar variables is indicated by the structure of the equation, then the usual assumptions require that the variance of the disturbance term be constant over time, when expressed in current dollars. Should the disturbances in the chosen form for the equation have the necessary characteristics for efficient estimation in terms of constant

rather than current dollars, one can still save the current-dollar equation by using weighted regression to get efficient parameter estimates.[4]

RDX1 treats all government expenditure on goods and services as exogenous, and to date we have devoted little time to the search for appropriate equations to explain expenditures. For the provincial and municipal governments, which often relate expenditures to the demand for services rather than the requirements of counter-cyclical fiscal policy, it may be possible to develop expenditure equations with independent variables that include the demand for government services, tax yields, and credit conditions.[5] For a few categories of federal expenditure this approach may also be fruitful.

3. Transfer Payments

Although most of the analysis of the characteristics of the federal budget as an 'automatic stabilizer' has been concerned with tax receipts, the cyclical variations in some transfer payments have been more marked than in the case of tax receipts. The transfer payments equations share the potential precision of the tax equations, since the enabling legislation usually defines the basis for the payments and stipulates a schedule of rates.

[4]If G is in current dollars, X in constant dollars, and P is the price level, we have (at least) two possibilities:

(a) $G = a_1 + b_1 PX + u_1$ where $E(u_1^2) = \sigma_1^2$

(b) $G/P = a_2 (1/P) + b_2 X + u_2$ where $E(u_2^2) = \sigma_2^2$

If (a) holds, then (b) does not, and vice versa. We want to get consistent estimates of a_1 and b_1. If (a) holds, there is no problem. If (b) holds, then the equation should be transformed to that form for estimation. a_1 and b_1 are then found easily, as $\hat{a}_1 = \hat{a}_2$ and $\hat{b}_1 = \hat{b}_2$. If the equation is used to provide point estimates only, no further problems arise. If the error properties are to be used for simulation purposes, the appropriate approximation for the standard error of the estimate is $\sigma_{u_2} P$, which varies with P.

[5]This kind of specification has been adopted for some state and local government expenditure equations in the F.R.B.-M.I.T. model, as outlined in Rasche and Shapiro [6].

The specification problems arise in developing the appropriate demographic and economic variables. As with the tax equations, it is important that the transfer payments equations be structurally apt. Thus they can be used easily and accurately to estimate the size and cyclical variability of a change in transfer payments induced by some change in the policy parameters defining the terms on which payments are made. Equations for the most important Canadian federal transfer payments are presented in Part 3 of this paper.

4. *Changes in Asset and Liability Accounts*

The most ambitious macro-models include a 'monetary sector' with equations showing how the private sector financial institutions adjust their portfolios in response to given changes in the monetary base and the rediscount rate (bank rate).[6] These equations occasionally explain the policy decisions that produce the 'given' changes in the monetary base. If changes in the monetary base are treated as a predetermined policy variable, then simultaneous equations bias will arise in the estimation of parameters unless one can assume that the policy authorities react only to predetermined variables.

The problem is not just that the usual models may have been founded on biased estimates because the exogeneity of the monetary base has been too freely assumed; but that, once the questioning has proceeded this far, one is tempted to wonder if the monetary base is the appropriate policy variable. It will be recalled from section A, that, given a total volume of debt outstanding, monetary policy through open market and debt management operations is free to decide only the term structure of that debt, including the split between money and interest-bearing debt.[7] Each term structure of the debt will, in general, produce a different term structure of interest rates. Do the authorities choose a feasible (attainable) term structure of interest rates for policy reasons, and then buy and sell securities so as to attain this structure?

[6] For example: de Leeuw [3], and Goldfeld [4].

[7] Other aspects of monetary policy——changes in bank rate, changes in required reserve ratios, moral suasion, etc.——are not considered in this paper. If these policy variables have some independent variance and identifiable impacts on behaviour they should be included explicitly in the model.

Or is a desired term structure of the government debt (including the monetary base) chosen and are interest rates then accepted at whatever magnitudes may be required to lodge the debt in private portfolios? The answer depends on what is regarded as the appropriate index of credit conditions. If the authorities make periodic decisions about the state of credit ease or tightness desired for policy reasons and describe that state in terms of interest rates; then those rates, which are the focus of attention, should be regarded as the policy variables. If the desired state of credit conditions is defined in terms of the size of the monetary base and other measures of the term structure of the debt, these measures should be regarded as the policy variables and interest rates should be determined as implicit endogenous variables. When monetary policy decisions are taken frequently, and when the authorities may be assumed to know roughly the extent and nature of open market operations implied by a chosen structure of interest rates and vice versa, then it will be difficult to tell which are the policy variables. If monetary policy has an identifiable 'posture' over fairly long periods, correlations between some index of this posture and the two candidate sets of policy variables might help to decide the issue. Since the financial sector of any comprehensive model contains equations indicating the demand for money and for bonds, including government bonds, the government sector of the model can contain only the equations determining the chosen values of the policy variables. Thus, if interest rates are assumed to be the policy variables, there can be no equations determining the amount of the various maturities of government debt bought or issued. Conversely, if the policy variables are thought to be the quantities of debt bought or issued, then there can be no interest rate equations, since the rates must equilibrate supply and demand for each maturity of government debt.

In RDX1, we have an explicit equation determining the short-term interest rate (R03) as a function of the U.S. treasury bill rate and the supply and demand for credit in Canada. The demand variable is equal to the sum of aggregate capital expenditures and the government national accounts deficit minus corporate retained earnings and capital cost allowances. The supply of credit is represented by the ratio of chartered bank earning liquid assets to the trend value of total chartered bank assets, with higher values of the ratio indicating faster expansion of

bank assets and greater willingness of banks to acquire securities. The cash base (BCD) of the banking system is treated as an exogenous policy variable, and the supply of interest-bearing government debt is therefore left to be determined by the flow-of-funds identity. We recognize that treating BCD as an exogenous variable may have led to some simultaneous equations bias in the estimation of the parameters of RDX1. This is possible either if interest rates rather than BCD are the main policy instrument or if the values given to the policy instrument, whichever it may be, are chosen with regard to contemporary disturbances elsewhere in the model.

Thus we see that no explicit equations are required for the debt items in Table 1, and the only asset-management equations needed are for the components of 2-3-2. The change in the "federal government claims on non-residents" item could be obtained, assuming appropriate adaptations, from the foreign sector of RDX1. We must build up the "investments in government enterprises" item from a knowledge of the specific, underlying legislation and estimates of future policy. The "taxes accrued but not collected" item can be estimated by procedures similar to those used for the tax collection equations, and the miscellaneous items must be treated by miscellaneous methods. Item 2-3-2-6 "corporate taxes accrued but not collected" is the only change in asset and liability accounts dealt with explicitly in this paper.

C. Using the Government Sector Equations

The equations for the government sector have a number of different uses. Detailed models of particular taxes, transfers, or expenditures may be used on their own to study, in a partial way, the consequences of alternative structures. For example, the choice between alternative patterns of exemptions and rates of personal income tax may depend, to some extent, on their effects on the efficiency of the tax as an automatic stabilizer. On certain assumptions about the relative spending propensities of those paying the tax when incomes are following various fluctuating growth paths, a model of the personal income tax can be used to assess the behaviour of tax receipts and the stabilizing effects of the tax. Such detailed analysis should reveal which are the key characteristics of the tax structure from the point

of view of stabilization, since it is relatively easy to do a sensitivity analysis using a range of values for each of the tax parameters.

Equations for government sector activity may also be included in models of the government sector as a whole or of the entire economy. A model of the government sector may be useful for forecasting the results of changes in interdependent taxes, transfers, and expenditures. However, the primary advantages of a well-specified government sector can only be achieved if it is linked to an appropriate macro-model. Linking the government sector to a model of the entire economy provides an automatic consistency check on the assumptions made about the time paths of various private sector income and expenditure items. If the macro-model can be developed to the point of explaining private sector balance sheet positions, then grafting the government sector on to a macro-model also allows alternative monetary policies to be analyzed.

The amount of extra information to be gained by linking the government sector models to a macro-model depends on the extent to which the two models are compatible. Maximum compatibility is achieved when all the variables (endogenous to the economy as a whole) used but not explained in one sector are explained in another.[8] An efficient specification of government sector equations for a given macro-model takes advantage of all the explanatory power of that macro-model (e.g. choosing the most appropriate series to define a tax base), yet does not have any unexplained

[8]Compatibility also requires that price variables be used consistently throughout a particular macro-model. It was suggested in section B that the entire government sector should be explained in current-dollar terms. The simplest possible price scheme would then be to obtain a single 'private' Gross National Expenditure implicit price deflator as the ratio of current-dollar to constant-dollar non-government expenditure. The consequences of different sorts of price aggregation on the specification of the government sector tax equations can be assessed by experimenting with more and less aggregated price indices when defining the current-dollar private sector expenditure series used as independent variables in the government tax receipts equations.

endogenous variables left over.[9] Particularly, if the values of important target variables are sensitive to alternative specifications of the group of government sector equations, then those equations should be specified with the utmost accuracy and structural detail.

The advantage of estimating government sector equations at various levels of aggregation and degrees of detail is that one can then see with relative ease how sensitive the forecasts of the dependent variables are to changes in the structure of the equations. This insight provides the model assembler with evidence that helps him to decide how much structural detail is worth giving up in order to obtain a smaller and more easily manipulated macro-model. The trade-off a particular model user is willing to make between simplicity and structural detail will depend on the potential gains from greater precision (which will in turn depend on the range of policy alternatives being assessed), and on the costs of estimation and simulation for models of different sizes.

Because considerable research is necessary to develop adequate data and equations for the government sector, much can be said for generating equations at various levels of structural detail and making them freely available to researchers interested in policy models. The wide distribution of suitable data and equations for the government sector can do much to improve the quality of estimated macro-models, and to clarify the issues in discussions of the relative merits of policy alternatives.

[9]For example, the different types of income——wages, salaries, farm income, dividends, etc.——go to people in different income classes in different proportions. Since the various types of income have distinct patterns of cyclical variation, and since the tax rates are progressive, an income tax model is likely to be more accurate if separate forecasts are available for each type of income. But there is no point in using an income tax model of this complexity unless the macro-model in question has separate explanations for each type of income.

PART 2 FEDERAL GOVERNMENT TAX REVENUE

In our index we split federal government revenue into three main categories: taxes, investment income, and insurance and pension accounts. Taxes are the predominant source of federal revenue, producing 86 per cent of the $9,059 million total in 1965. This part of the paper contains an explanation of six taxes (see Table 2), which in aggregate provided 95 per cent of 1965 federal tax revenue, or 82 per cent of total federal government revenue. In Part 3 of the paper we explain, as segments of our models of the Public Service Superannuation Account (2-1-6-1) and of the Unemployment Insurance Fund (2-1-6-2), the revenue components of the federal government insurance and pension accounts. The six tax equations plus these insurance and pension fund revenue equations explain 90 per cent of total 1965 federal revenue. We treat investment income and revenue from a variety of small taxes as exogenous. They can be fairly easily forecast as a group by means of a regression on Gross National Expenditure (GNE).

Because the rates and structural features of certain taxes are thought of as instruments of public policy, we decided to deal with these taxes in detail. Our aim is to make explicit the major elements of the tax structure that might reasonably be altered for policy purposes, and to relate tax revenues as precisely as we can to the appropriate tax base. Where possible, we used variables that match the legal tax base and that are also either predictable exogenous variables or endogenous variables likely to be explained within a macro-model.

All of these taxes, except the corporation income tax, are recorded in the *National Accounts* on a collection basis.[10] The corporation tax is recorded on an accrual basis, which means that there is a discrepancy between the tax revenue as recorded in the *National Accounts* and the actual flow of funds to the federal

[10]Beginning in 1962, the withholding tax series was adjusted by shifting collections back one month to make the series conform more closely with the flow of interest and dividends to non-residents. This, in effect, puts the series on an accrual basis. Since revenue from the withholding tax is relatively insignificant, we have not taken into account the difference between withholding tax accruals and collections when explaining federal revenues on a cash basis.

Table 2

FEDERAL GOVERNMENT TAX REVENUE MODELLED
(Millions of dollars)

Index Code No.		1965 Revenue
2-1-1-1	Personal income tax	2,612
2-1-2	Corporation income tax accruals	1,675
2-1-3	Non-Resident withholding tax	168
2-1-4-1	Customs duties	665
2-1-4-2	Manufacturers' sales tax	1,837
2-1-4-4	Excise duties	431
	Total	7,388

government. To explain federal tax revenues on a cash basis, therefore, we need an additional relationship defining, for each period, the difference between corporation taxes accrued and corporation taxes collected. This relationship is discussed in section 2-3-2-6 below.

The two largest revenue sources, the personal and corporation income taxes, are shared by the provincial and federal governments. In this part of the paper we explain the total yield of these taxes, and suggest (in conjunction with sections 3-1-1-1 and 3-1-3-1 of Part 4) how the federal and provincial portions of that total yield may be separated. Economists preparing macro-models with fairly simple government sectors may prefer to use the models for the combined federal and provincial income taxes; in constructing such models there is no need to split revenues into federal and provincial components.

2-1-1-1 PERSONAL INCOME TAX

We have developed two models of the personal income tax,[11] either of which could be used in an aggregate macro-model. *Model 1* disaggregates personal income both by type of income and by income level, while *Model 2* disaggregates only by income level.[12]

In *Model 1* total personal income is split into wage income (WSSL) and nonwage personal income (NW).[13] This separation allows us to take explicit account of the differing methods of collecting income tax and the payment of refunds on WSSL and NW. Since wages are taxed mainly by deductions at source, and since the tax on nonwage income is usually paid in quarterly instalments, we treated

[11]The complete sets of equations for these models are given on pp. 47-50, followed by definitions of all the variables included.

[12]After trying various income-class sizes, we chose four income classes based on assessed income: Class 1, zero to \$3,000; Class 2, \$3,000 to \$5,000; Class 3, \$5,000 to \$10,000; Class 4, over \$10,000.

[13]Throughout this part of the paper, wage income (WSSL) refers to wages, salaries and supplementary labour income, while all other personal income is referred to as nonwage income (NW). The major components of NW are: net farm income; interest, dividends and rental income; and transfer payments, excluding interest on the public debt.

these two methods of collection separately, allowing each method to have its own lag distribution relating tax payments to income. A different time pattern of refunds is also involved for each type of income. Taxes on wages in most instances are overpaid during the year, therefore year-end adjustments involve refund payments to the taxpayer. On the other hand, quarterly tax instalments on nonwage income tend to be less than the accrued tax liability so that nonwage taxpayers must often pay additional taxes at the year-end. Most refunds are made between March and the end of June while make-up payments on nonwage income are made primarily during the second quarter. In *Model 1* we accounted for both these processes by using variables specifically related to each type of income. Since the primary object in constructing a policy-oriented model is to make explicit as much of the tax structure as is feasible, disaggregation by type of income is to be preferred if it does not yield inferior results.

The problems that arose from disaggregating income by type were sufficient, however, to make a second approach desirable. The main obstacle encountered in constructing *Model 1* concerned data. Although personal income data were available split into wage and nonwage components, many other supporting series could not be correspondingly disaggregated. In *Model 2*, the use of aggregate income allows us to avoid some of the error that was introduced into *Model 1* through the use of variables based on data arbitrarily split into wage and nonwage components.

However, in *Model 2* we cannot take explicit account of the different tax treatment accorded to wage and nonwage income. As well, the reliability of this model's compound payment and refund variables depends crucially upon how stable the relationship is between wage and nonwage income. While over our estimation period this relationship has not been constant, we think it has been sufficiently fixed to make the aggregate approach a reliable alternative to the method used in *Model 1*. Thus *Model 2* is considerably smaller and less complex than *Model 1*. Also the relative simplicity of *Model 2* may be more valuable for some purposes than the additional information retained by disaggregation.

Personal income is disaggregated by income level in both models owing to progressive tax rates. The usual way of dealing with progressivity in the rate structure is to measure the income

elasticity of the tax according to past changes in total income, and then assume that the same elasticity will apply to future changes in income. This assumption is inappropriate if the rate structure is not uniformly progressive, or if aggregate income changes are not distributed evenly over time amongst income classes. In any case, a personal income tax model disaggregated by income class is worthwhile because this model can be used to simulate the aggregate effects of a variety of changes in the level and structure of tax rates. A policy-oriented model of the personal income tax should also identify the nature and amount of exemptions and deductions by income class so that the revenue consequences of changes in these allowances may be more accurately assessed.

When building a personal tax model to be included in the government sector of a macro-model, one must not only choose the level of disaggregation but one must also decide which of the required variables should be made endogenous to the macro-model and which should be generated outside. If a variable used exogenously in the tax model depends crucially on the value of some other variable endogenous to the macro-model, the former variable should also be made endogenous to the macro-model. On the other hand, if the future values of a variable can be better forecast by a scheme that does not depend in an important way on the values of other endogenous variables of the macro-model, then this variable can safely be generated outside the model and treated as an exogenous input to both the tax sector and the entire macro-model. If the model is to be used by other economists, some instructions should be provided to aid them in forecasting the future values of the exogenous, as well as the endogenous, variables. Therefore, in the discussion that follows, we shall try to identify any regularities that will make it easier to forecast the exogenous variables.

Our experiments yielded good equations for both models, so, depending upon one's objective and the size of the model with which one wishes to work, either can be used. *Model 2* may be chosen for forecasting purposes, while for policy analysis the more structurally-explicit *Model 1* should be preferred.

The larger model, *Model 1*, has five stochastic equations explaining tax collections at source (TPS), other income tax collections (TPO), total number of tax returns (NT), assessed wage

income (WAS), and assessed nonwage income (NWAS). Two non-stochastic equations, based on the tax law, define tax accruals on wages (AW) and accruals on nonwages (ANW). These two equations in turn depend upon five exogenous variables: quarterly average utilized exemptions and deductions for wage and nonwage income ($\overline{WEX}$, $\overline{NEX}$ respectively), the weighted average tax rate (RW), the rate of dividend tax credit (RDC), and dividends paid by Canadian corporations to Canadian residents (DIVC). To define NT by its components, wage tax returns (NTW) and nonwage tax returns (NTNW), and then to separate NT, NTW, NTNW, WAS and NWAS into each of the four income classes, we require another twenty identities. These identities depend upon nine exogenous ratios: N_i, W_i, and NW_i, (i = 1, 2, 3).

Because *Model 2* is based on aggregate income its structure is much simpler than that of *Model 1*. Only three stochastic equations are required: one for total tax collections (TP), a second for total assessed income (YAS), and a third for the total number of tax returns, NT. Notice that TP = TPS + TPO, and YAS = WAS + NWAS. One non-stochastic equation is needed to obtain total tax accruals (AY), and this equation requires four exogenous variables: average quarterly utilized exemptions and deductions ($\overline{YEX}$), RW, RDC, and DIVC. Except for $\overline{YEX}$, these exogenous terms are the same as those used in *Model 1*. Since in *Model 2* it is not necessary to split NT and YAS into income-type components, only eight identities are needed to define these variables for the four income classes. Six exogenous ratios are used in these identities: N_i and Y_i (i = 1, 2, 3).

Finally, total personal income (YP), wages, salaries and supplementary labour income (WSSL), and nonwage income (NW) (where YP = WSSL + NW) are exogenous to both models, although naturally endogenous to almost any macro-model in which either income tax model might be used. WSSL and NW are required in the WAS and NWAS equations of *Model 1*, while YP is used in a similar equation for YAS of *Model 2*.

Thus there are twenty-seven endogenous variables in *Model 1* and twelve in *Model 2*——the number of endogenous variables equals the number of equations in each model. Seventeen exogenous variables are used in *Model 2*, while twenty-four are required for *Model 1*. At the end of this section all the variables are listed

and defined. Data sources are also given. A detailed discussion of the methods used in constructing many of the variables is contained in the data appendix, pages 138-148. We also suggest forecasting schemes that might be useful in predicting future values of most of the exogenous variables.

A. Model 1

Relating tax collections to income involves two conceptual steps, and both differ for wage and nonwage income. The first step is to determine tax accruals on the basis of income earned, exemptions, and tax rates. The second step is to estimate the timing of the process by which a given time series of tax accruals gives rise to tax collections and refunds. In the case of the corporation income tax one can estimate separately the parameters applicable to each conceptual step, since data are available for corporate tax accruals as well as corporate tax collections. For the personal income tax, however, we have data only for collections, so that we must estimate all the parameters jointly.

1. *Tax Accruals on Wage Income* (AW)

The links between income and tax accruals on the one hand, and accruals and tax collections on the other, are simpler for the wage than for the nonwage equation. Tax accruals for wages (AW) are obtained by subtracting quarterly utilized exemptions[14] and deductions from assessed wage income in each of the four income classes, then multiplying this taxable income by the weighted average tax rate for each class and summing over the four classes.

$$AW = \sum_{i=1}^{4} RW_i \left[WAS_i - (NTW_i)(\overline{WEX_i})\right] \qquad (1.1)$$

Each of the accrual equations is based on the assumption that, within any given income class, all taxpayers earn the mean pre-tax income in that class, receive an average level of exemptions (primarily dependent upon the average family structure for that

[14]The term "utilized exemptions" is explained in detail in the data appendix.

class), and incur tax liabilities according to the current tax rate schedule applied to their taxable income.

The WAS_i are obtained from a stochastic equation giving estimated WAS, ($\hat{WAS}$), and four identities described on pages 29 to 34. The NT_i are also obtained from a stochastic equation that estimates NT, ($\hat{NT}$), and four similar identities outlined on page 29. Each NT_i is split into a wage and nonwage component (NTW_i and $NTNW_i$ respectively) by the identities discussed on pages 34 and 35. Quarterly average utilized exemptions for wage income, $\overline{WEX}_i$, are derived by allocating to each quarter average annual exemptions and deductions ($\overline{EX}_i$), (obtained from *Taxation Statistics*)[15] according to a ratio of quarterly $\hat{WAS}$ to annual $\hat{WAS}$. This ratio is given in the data appendix. The ratios for $N\hat{WAS}$ and $Y\hat{AS}$, which are used to derive the similar quarterly exemption series $\overline{NEX}_i$ and $\overline{YEX}_i$, also appear in the data appendix. We tried a constant allocation of .25 of the annual series $\overline{EX}_i$ in our earlier experiments, but the above procedure gave better results. A priori it seems plausible that the quarterly pattern of utilized exemptions would be related to the quarterly movement of assessed income.

2. Tax Collections——Deductions at Source (TPS)

Deductions at source, TPS, are related to estimated AW lagged one month (since deductions are recorded in the *Public Accounts*[16] in the month following that to which they relate), plus first- and second-quarter adjustment terms, to reflect refunds. These refunds are assumed to be proportional to the total tax

[15] *Taxation Statistics, Part One (Individuals)* issued annually by the Department of National Revenue.

[16] *Public Accounts of Canada* issued annually by the Department of Finance.

liability of the relevant year.[17] Thus

$$TPS = \beta_1 \, [2/3 \, AW + 1/3 \, AW_{t-1}] + \beta_2 Q_1 \sum_{j=-1}^{-4} AW_{t+j} + \beta_3 Q_2 \sum_{j=-2}^{-5} AW_{t+j} \qquad (1.2)$$

Equation (1.2) was fitted to quarterly data and the results are discussed below, beginning on page 42.

3. *Tax Accruals on Nonwage Income* (ANW)

The relationships of income to accruals and of accruals to collections are slightly more complicated for nonwage income than for wage income. In calculating ANW one must consider the dividend tax credit[18] that permits taxpayers to reduce their tax liability by a certain fraction of dividends received from taxable Canadian corporations. Thus

$$ANW = \sum_{i=1}^{4} RW_i \, [NWAS_i - (NTNW_i)(\overline{NEX}_i)] - RDC \, (DIVC) \qquad (1.3)$$

The $\overline{NEX}_i$ term is obtained from $\overline{EX}_i$ in the same manner as $\overline{WEX}_i$—using a ratio of quarterly $NW\hat{A}S$ to annual $NW\hat{A}S$. The derivation of $NWAS_i$ and $NTNW_i$ is described below.

4. *Tax Collections—Other* (TPO)

The collection equation for nonwage income is also more complex than that for wage income, primarily because the nonwage taxpayer has the option of basing quarterly instalment payments on

[17] All subscripts relating to time represent quarters of a year. Hence, the first summation in equation (1.2) refers to the four quarters preceding quarter t. The Q_i are quarterly dummies with a value of 1 in the specified quarter, zero otherwise.

[18] From 1949 until 1953 the rate of dividend tax credit was 10 per cent. Since then it has been 20 per cent.

either actual taxable income in the previous year or on an estimate of income for the current year. Thus the behaviour underlying the equation may shift if incomes follow a pronounced cycle. When incomes are rising fast most nonwage taxpayers would choose to base their instalments on their tax liabilities for the preceding year, while when aggregate income is rising slowly or falling many nonwage taxpayers may choose the other option and pay on the basis of the current year's estimated income. Since most incomes have been rising generally throughout our data period, we have assumed that nonwage taxpayers in general prefer to pay on the basis of the previous year's taxable income. This gives the basic equation:

$$TPO = \beta_1 Q_1 \sum_{j=-1}^{-4} ANW_{t+j} + \beta_2 Q_2 \sum_{j=-2}^{-5} ANW_{t+j} + \beta_3 Q_3 \sum_{j=-3}^{-6} ANW_{t+j} + \beta_4 Q_4 \sum_{j=-4}^{-7} ANW_{t+j} \quad (1.4)$$

One could add to this equation various cyclical variables intended to capture the changes in payment practices accompanying changes in the proportion of taxpayers with declining incomes. The results of some experiments with a number of these alternative cyclical variables are discussed on pages 45 and 46. Note that this equation requires a separate term for each quarter, not only to take account of refunds and supplementary payments, but also because the quarterly instalments are based on a particular calendar year. This necessitates a different summation expression on ANW_{t+j} for each quarter.

In support of these four main equations of *Model 1* are the following twenty-three equations and identities:

$$NT = f_1 \ (NE, T) \quad (1.5)$$

$$WAS/WSSL = f_2 \ (NU/NL, T) \quad (1.6)$$

$$NWAS = f_3 \ (NW) \quad (1.7)$$

$$NT_i = N_i\ (NT) \quad (i=1,2,3) \qquad (1.8 \text{ to } 1.10)$$

$$NT_4 = NT - \sum_{i=1}^{3} NT_i \qquad (1.11)$$

$$WAS_i = W_i\ (WAS) \quad (i=1,2,3) \qquad (1.12 \text{ to } 1.14)$$

$$WAS_4 = WAS - \sum_{i=1}^{3} WAS_i \qquad (1.15)$$

$$NWAS_i = NW_i\ (NWAS) \quad (i=1,2,3) \qquad (1.16 \text{ to } 1.18)$$

$$NWAS_4 = NWAS - \sum_{i=1}^{3} NWAS_i \qquad (1.19)$$

$$NTW_i = (NT_i)\ [(WAS_i)/(WAS_i + NWAS_i)] \quad (i=1,2,3,4) \qquad (1.20 \text{ to } 1.23)$$

$$NTNW_i = NT_i - NTW_i \quad (i=1,2,3,4) \qquad (1.24 \text{ to } 1.27)$$

5. *Total Number of Tax Returns Filed* (NT)

The total number of tax returns filed each year is closely related to the income earning population. Everyone, other than the dependent of a taxpayer, is required by tax law to submit a return declaring his income whether taxable or not. This law should result in NT almost equalling the total civilian labour force (NL). But NT and NL are not equal as Chart 1 reveals. Part of the difference is accounted for by workers who are unemployed for the entire year (they have no incomes and hence file no returns), and workers who fail to file returns. Much more numerous, however, are taxpayers' dependents who enter the labour force but do not earn sufficient income to lose their dependent status—hence they need not file tax returns. Also, the group of taxable income earners who are over sixty-five and retired is increasing rapidly in importance as a component of the difference between NT and NL.

Chart 1

TOTAL CIVILIAN LABOUR FORCE, EMPLOYMENT AND TAX RETURNS

Millions

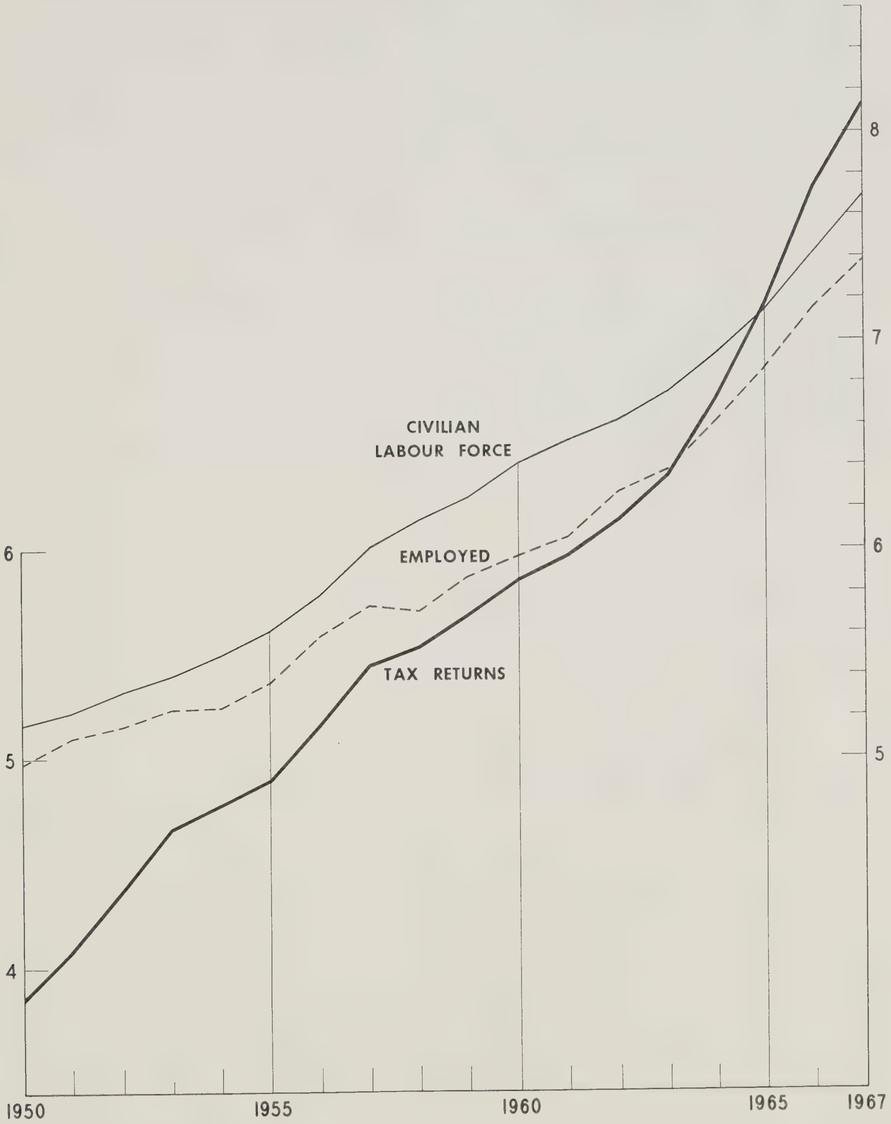


Chart 1 shows the relative movements of the total civilian labour force, NL, employed labour force (NE), and total tax returns, NT. A large upturn of NT beginning in 1964, not matched by corresponding upturns in NL and NE, poses a problem if equation (1.5) below is to be used for forecasting. This sharp upward movement obviously cannot be sustained. The explanation may be an accelerated growth in the group of taxpayers who do not form part of the labour force, for example pensioners. Taxpayers over sixty-five years of age filed 7 per cent of total tax returns in 1966, as compared to only 2 per cent in 1954. An additional variable accounting for this shift should be employed in equation (1.5) if it is used to estimate NT beyond 1965.

We tried a number of equations using both total civilian labour force, NL, and the employed labour force, NE. There was no great difference between them, but the variance of NE was considered to be more related to the pattern of NT we desired. Then, besides NE, a time trend was included (T = 1 in 1950) to measure the secular growth in NT since 1950. The annual equation is:[19]

1950-1965

$$\underset{}{NT} = \underset{(66.86)}{.7930\,(NE)} + \underset{(14.36)}{101.78\,(T)} \qquad (1.5)$$

SEE = 107.7 $\qquad \bar{R}^2 = .987 \qquad$ D/W = .553

where NT, NE are in thousands.

In fitting the tax collection equations, we tried a number of different assumptions about the quarterly movements in NT. We found that using the coefficients from the annual equation with quarterly values of the independent variables to produce different values of NT for each quarter yielded the best results. This procedure was also followed in deriving the quarterly values from annual estimates for the three income variables, WAS, NWAS, and YAS.

[19]In all the equations that follow the coefficients have been estimated by the method of ordinary least squares (OLS). With each equation we indicate the absolute value of Student's t statistic in parentheses, the standard error of the estimate (SEE), the adjusted coefficient of determination ($\bar{R}^2$), and the Durbin/Watson measure of serial correlation (D/W). All money equations are estimated in millions of current dollars.

The NT_i, equations (1.8) to (1.11), are obtained from NT using three of four ratios calculated from the *Taxation Statistics*, where $N_i = NT_i/NT$ and $\sum_{i=1}^{4} N_i = 1$. The quarterly values for each N_i are derived by a fourth quarter to fourth quarter linear interpolation of the calculated annuals. Only three ratios are required, since the fourth can be obtained as a residual. Chart 2 shows the movement of each of the interpolated ratios.

6. *Total Assessed Income, Wage* (WAS) *and Nonwage* (NWAS)

Total assessed wages and nonwages are derived stochastically from their national accounts personal income counterparts, WSSL and NW. There are a number of differences between income as defined for tax purposes and as recorded in the *National Accounts*. Transfer payments to persons (excluding Old Age Security transfer payments) and corporations' charitable contributions are not considered to be income for tax purposes but are included in personal income in the *National Accounts*. There is also a great deal of under-reporting on tax forms of such items as farm income, interest, and dividends.

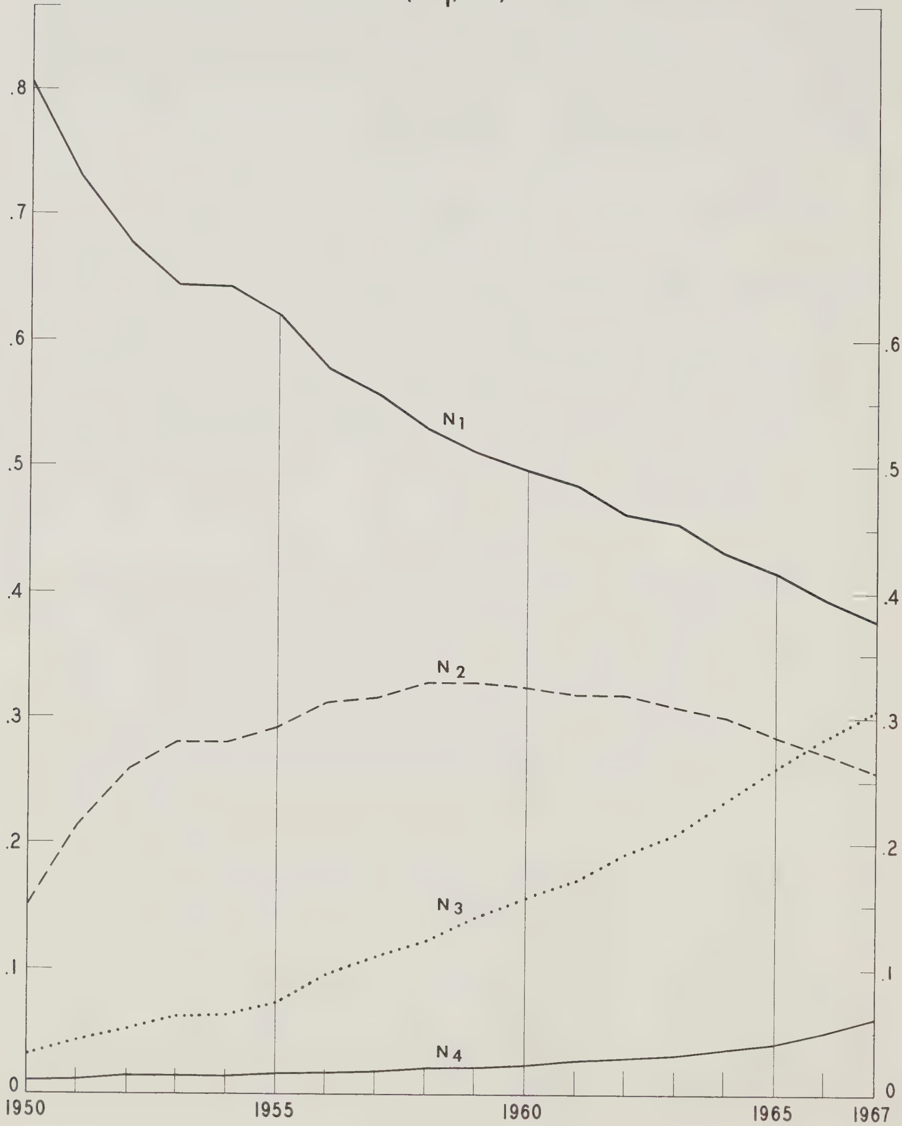
WAS as a proportion of WSSL has risen from 88 per cent in 1950 to 99 per cent in 1965,[20] indicating the increasing efficiency of the deductions-at-source method of taxing WAS. On the other hand, NWAS has averaged 35 per cent of NW over this period with very little variance about that average. Non-taxable transfer payments and corporate charitable contributions account for approximately 40 per cent of the difference between NWAS and NW, thus providing a rough indication of the amounts not reported on tax returns.

WAS and NWAS were first estimated from the annual taxation statistics data, then distributed quarterly using the annual coefficients and the quarterly values of the independent variables.

[20]Employer and employee contributions to social insurance and government pension funds (SSPS), are treated as government revenue in the *National Accounts* and hence deducted from personal income. Since the greatest proportion of these contributions is from wages and salaries, we have split this deduction between WSSL and NW in the proportions of 9 to 1. This means WSSL is reduced by .9 SSPS and NW by .1 SSPS in our equations.

Chart 2

PROPORTION OF TOTAL TAXPAYERS IN EACH INCOME CLASS
(NT_i/NT)



In equation (1.6) we estimated the quarterly ratio WAS/WSSL using the above procedure. We then used this ratio with WSSL[21] to derive quarterly $\hat{WAS}$. WAS/WSSL is made dependent upon the unemployment rate and a time trend equal to 1 in 1950.

1950-1965

$$WAS/WSSL = \underset{(2.60)}{.4339}\ (NU/NL) + \underset{(15.13)}{.0081}\ (T) + \underset{(125.25)}{.8450} \qquad (1.6)$$

SEE = .008 $\quad \bar{R}^2 = .967 \quad$ D/W = 1.22

The NWAS equation is much simpler than equation (1.6), making use of the quite stable relationship between NWAS and NW.

1950-1965

$$NWAS = \underset{(99.65)}{.3555}\ (NW) \qquad (1.7)$$

SEE = 130.6 $\quad \bar{R}^2 = .980 \quad$ D/W = 1.40

To disaggregate WAS and NWAS by income class we used six exogenous ratios, W_i and NW_i (Charts 3 and 4) where:

$$W_i = WAS_i/WAS$$

$$NW_i = NWAS_i/NWAS \quad (i=1,2,3, \text{ or } 4)$$

These ratios are similar to the N_i, obtained from the *Taxation Statistics*, and their quarterly values are also derived by interpolation of the annual series. Only three ratios are required the ratio for the fourth income class being a residual.

To obtain future values for these ratios (and for the N_i, Chart 2), one would extrapolate. The various ratios follow quite distinct time paths. There is an obvious movement of a modal body

[21] That is, WSSL - .9 SSPS as indicated in the preceding footnote.

Chart 3

PROPORTION OF TOTAL ASSESSED WAGE INCOME IN EACH INCOME CLASS
(WAS_i/WAS)

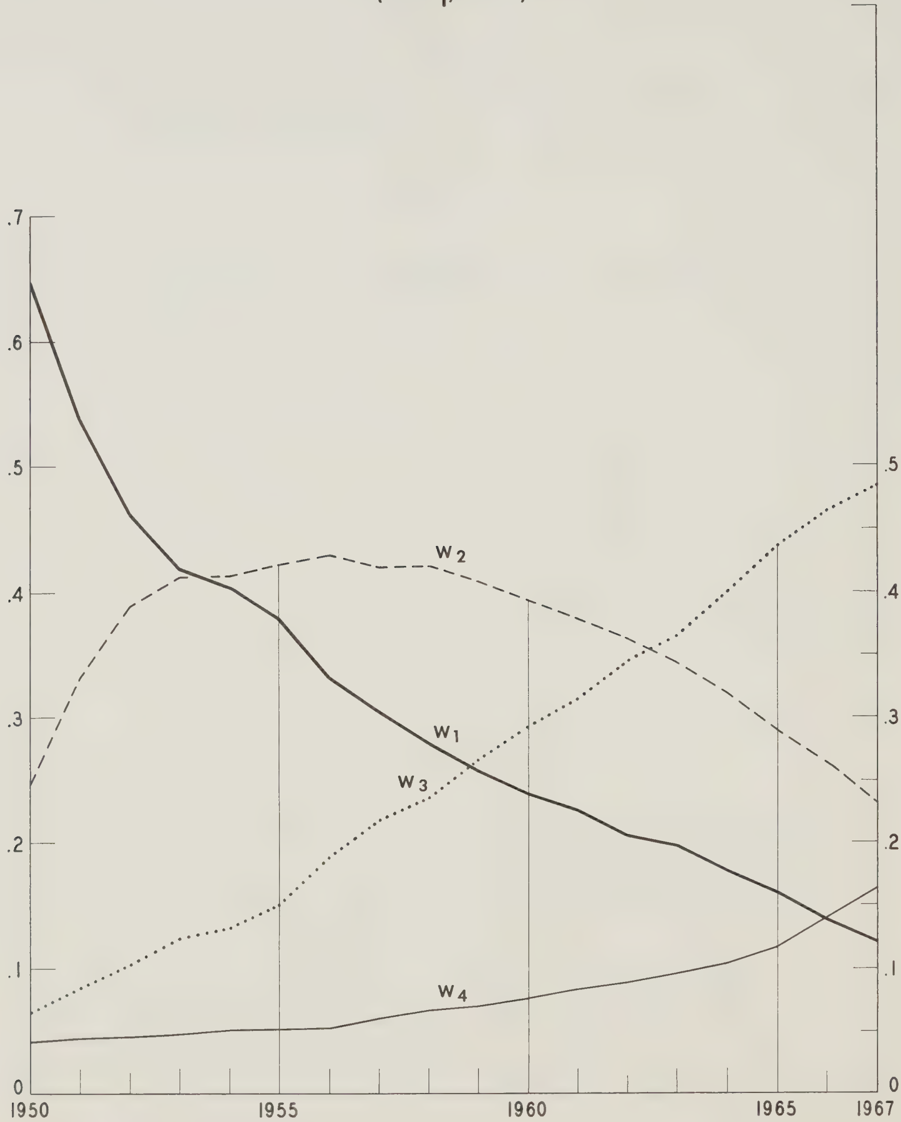
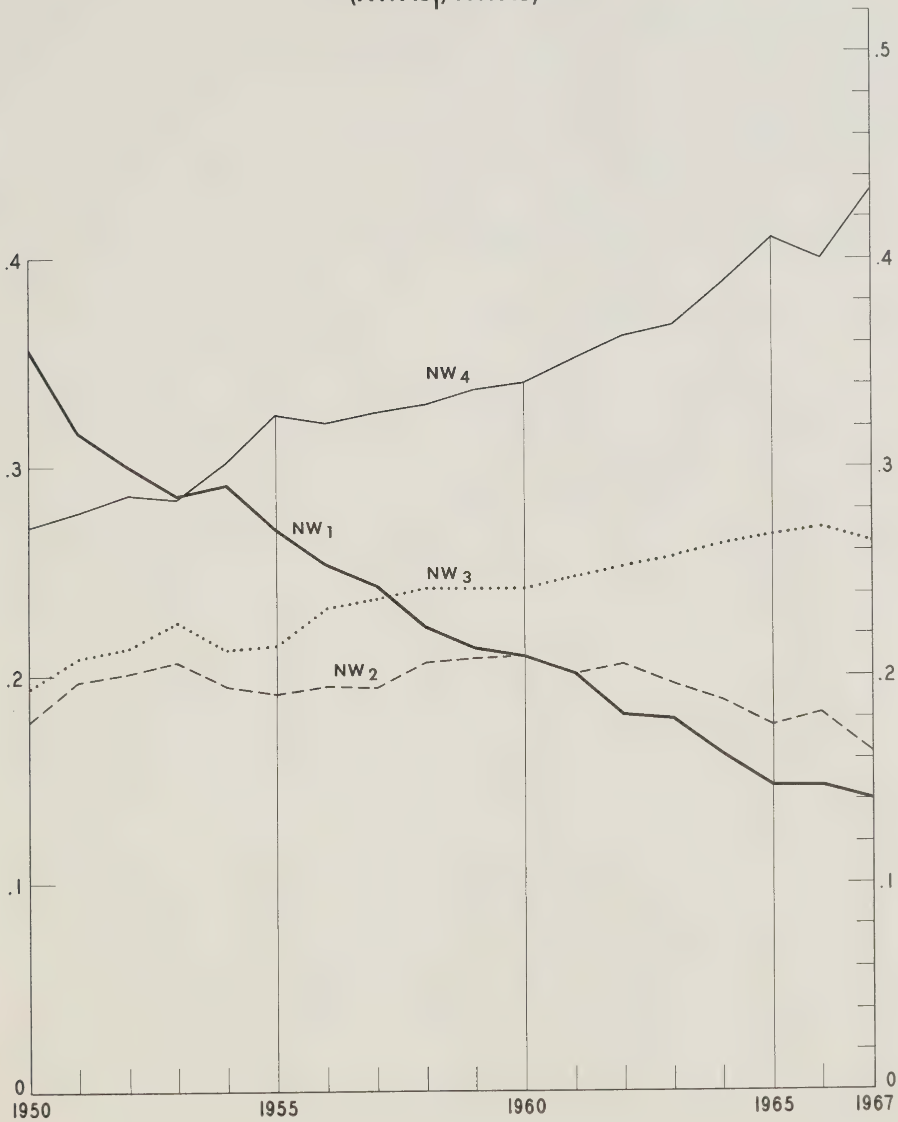


Chart 4

PROPORTION OF TOTAL ASSESSED NONWAGE INCOME IN EACH INCOME CLASS
($NWAS_i$/NWAS)



of income and a related group of taxpayers from lower to higher income classes, beginning in 1950 in Class 1 and now passing through Class 3. As the charts show, the relative size of Class 1 has steadily declined since 1950. As average levels of incomes increased, fewer people were being taxed in the lowest group and more in the next. The net increase in Class 2 continued until the mid-1950's when the growth of Class 3 accelerated. The relevant ratios should peak when income levels reach a point where the modal group of taxpayers moves into Class 4 and the relative number of Class 3 taxpayers begins to decline. One cannot now determine when this will happen. However, the movement of average taxable income will provide a clue to the possible turning point, which, of course, depends upon the future growth rate of income.

7. Number of Tax Returns Filed, Wage (NTW) *and Nonwage* (NTNW)

Equations (1.20) through (1.27), defining total taxpayers by income class and income type, depend on the preceding allocation of quarterly NT, WAS and NWAS into their respective income classes, and on the assumption that in each class average assessed wages are equal to average assessed nonwages. This assumption is obviously not valid for all classes, if for any, since a taxpayer can be a wage earner and also a nonwage earner. It is necessary to make the assumption, however, in order to obtain the split series for NT_i. Hence, by assumption, we have

$$WAS_i/NTW_i = NWAS_i/NTNW_i$$

Using this assumption and the two identities

$$YAS_i = WAS_i + NWAS_i$$

$$NT_i = NTW_i + NTNW_i$$

we obtain estimates for the unknown variables NTW_i and $NTNW_i$. From the assumption we get

$$NTNW_i = [NWAS_i/WAS_i]\ NTW_i$$

Substituting the definition of $NWAS_i$ and rearranging the terms we have

$$NTNW_i = [(YAS_i - WAS_i)/WAS_i]\ NTW_i$$

$$= [(YAS_i/WAS_i - 1)]\ NTW_i$$

$$= (YAS_i/WAS_i)\ NTW_i - NTW_i$$

That is,

$$NTNW_i + NTW_i = (YAS_i/WAS_i)\ NTW_i$$

Then, using the second identity, for NT_i, and rearranging the terms we have

$$NTW_i = (WAS_i/YAS_i)\ NT_i$$

Therefore, knowing the quarterly values of WAS_i, YAS_i, and NT_i we can obtain an estimate for the quarterly tax returns of wage earners in the i^{th} income class.

Similarly, quarterly tax returns of nonwage-income taxpayers can be derived as

$$NTNW_i = (NWAS_i/YAS_i)\ NT_i$$

However, if NTW_i is calculated then $NTNW_i$ can be obtained as a residual from the identity for NT_i. Equations (1.24) to (1.27) of *Model 1* are based on this procedure.

8. Weighted Average Tax Rates and Average Exemptions

The methods we used to construct the RW_i and average utilized exemptions are given in the data appendix. Calculated values of these variables are shown in Charts 5 and 6 below.

Chart 5

WEIGHTED AVERAGE PERSONAL INCOME TAX RATES

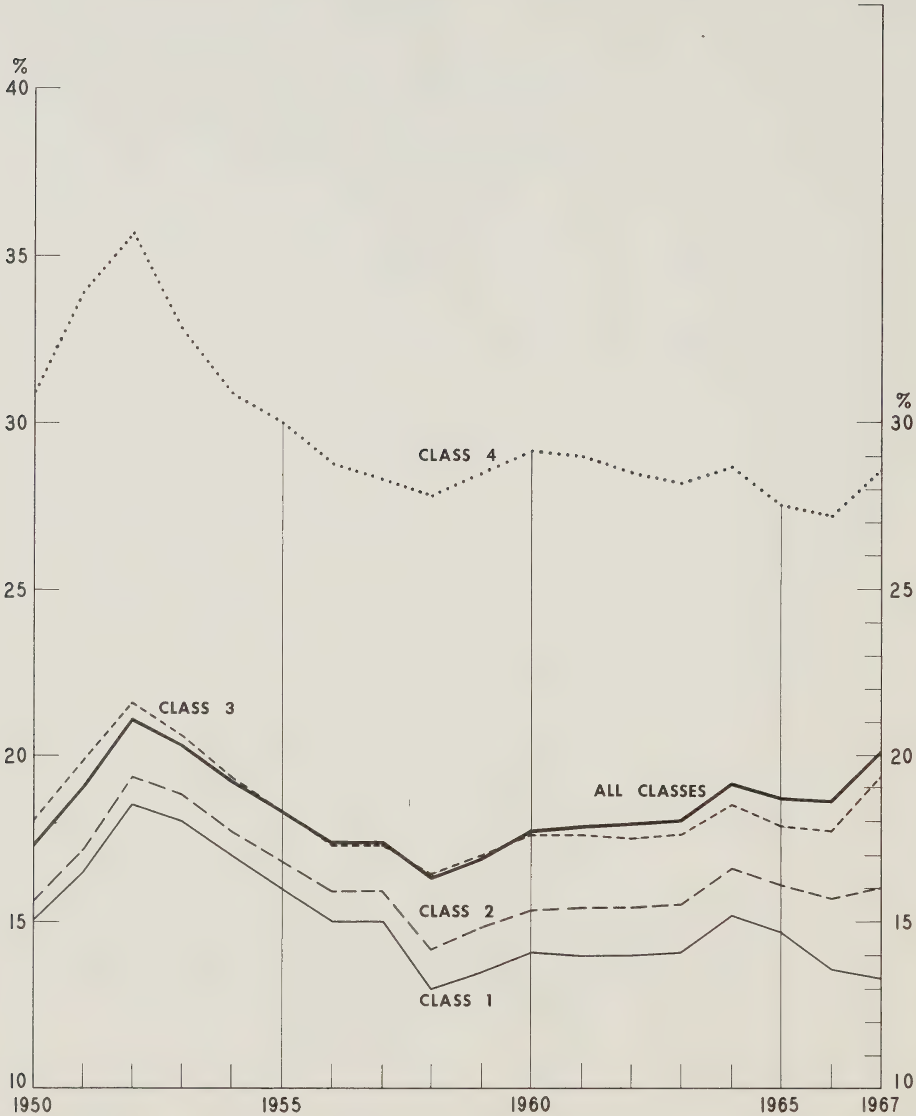
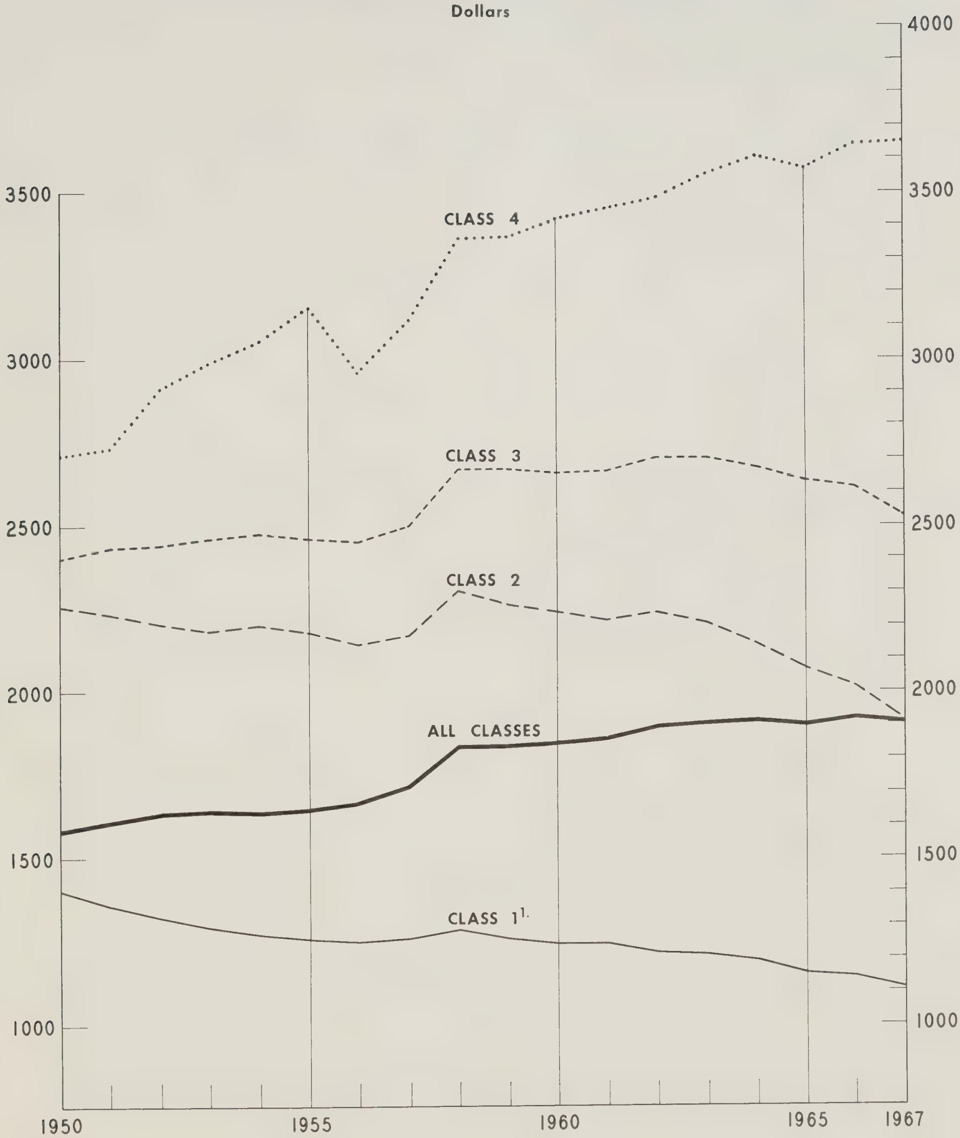


Chart 6

AVERAGE UTILIZED EXEMPTIONS AND DEDUCTIONS

Dollars



1. Average exemptions in Class 1 are adjusted for the unutilized exemptions of non-taxpayers whose total exemptions are greater than assessed income. The ratio of utilized to total exemptions is given in the data appendix.

B. Model 2

Model 2 is essentially the same in structure as the wage portion of *Model 1*, with the addition of an adjustment for the dividend tax credit.

$$AY = \sum_{i=1}^{4} RW_i \, [YAS_i - (NT_i)(\overline{YEX_i})] - RDC\ (DIVC) \qquad (2.1)$$

Hence,

$$TP = \beta_1 \ (2/3\ AY + 1/3\ AY_{t-1}) + \beta_2 Q_1 \sum_{j=-1}^{-4} AY_{t+j} + \beta_3 Q_2 \sum_{j=-2}^{-5} AY_{t+j} \qquad (2.2)$$

The YAS_i in equation (2.1) are obtained endogenously from an equation estimating annual YAS (spread quarterly in the same way as WAS and NWAS) and three exogenous ratios. The NT_i are derived from the equation for NT and three exogenous ratios. A definition of $\overline{YEX_i}$ appears in the data appendix. As for the remaining variables, the RW_i and RDC are exogenous policy variables while DIVC is exogenous to the tax sector, usually being explained elsewhere in a comprehensive macro-model.

In *Model 2* the nonwage portion of tax collections is implicitly related to the current quarter's tax liability, ANW_t (ANW_t being part of AY_t in equation (2.2)), and not to past quarters as it is in equation (1.4) of *Model 1*. During periods of rising income this would tend to bias our estimates of TP upwards, but since TPO is only 15 to 20 per cent of TP, the aggregate influence is not likely to be very great.

The first- and second-quarter refund terms in equation (2.2) represent a compound of year-end wage refunds and nonwage make-up payments, each concentrated in these first two quarters. In general, supplementary payments on ANW are greater than refunds for overpayment on AW. This produces a net addition to TP over and above regular quarterly tax revenue during the first and second quarters.

Note also that the two main policy variables, the weighted rate, RW, and quarterly average exemptions, $\overline{YEX}$, are the same in each of the accrual equations—equations (1.1), (1.3) and (2.1).[22] As we mentioned above, data disaggregated by type of income were not available; therefore we had to use some arbitrary method when splitting most of the supporting variables. In the case of RW and $\overline{EX}$, however, attempts to construct such split series yielded very little more than we otherwise obtained. Hence many of the variables used in the aggregate *Model 2* are the same as those already introduced in *Model 1*.

In support of equations (2.1) and (2.2) there are ten other equations and identities in *Model 2*:

$$NT = f_1\ (NE,\ T) \qquad (2.3)$$

$$YAS = f_2\ (YP) \qquad (2.4)$$

$$NT_i = N_i\ (NT) \quad (i=1,2,3) \qquad (2.5 \text{ to } 2.7)$$

$$NT_4 = NT - \sum_{i=1}^{3} NT_i \qquad (2.8)$$

$$YAS_i = Y_i\ (YAS) \quad (i=1,2,3) \qquad (2.9 \text{ to } 2.11)$$

$$YAS_4 = YAS - \sum_{i=1}^{3} YAS_i \qquad (2.12)$$

1. Total Number of Tax Returns Filed (NT)

Equations (2.3), and (2.5) to (2.8), estimating NT and defining it by income class, are the same equations as those used in the first model, equations (1.5), and (1.8) to (1.11).

[22]This is essentially true for $\overline{YEX}$, $\overline{WEX}$ and $\overline{NEX}$ because they are each derived from the annual series for total average utilized exemptions ($\overline{EX}$), and differ among themselves only on the basis of their quarterly pattern.

2. Total Assessed Personal Income (YAS)

YAS is derived from national accounts personal income, YP. Like its wage and nonwage components, total assessed income differs from YP by the amount of unreported and non-taxable income. YAS as a per cent of YP has increased since 1950 from 67 to 77 per cent, averaging 74 per cent over the fifteen-year period. The growth in this proportion represents primarily the increased coverage of the wage component of income, as described earlier.

The equation for YAS was fitted using annual data.

1950-1965

$$YAS = \underset{(71.99)}{.8153}\ (YP) - \underset{(6.81)}{1974.74} \qquad (2.4)$$

SEE = 324.4 $\qquad \bar{R}^2 = .997 \qquad$ D/W = 1.52

Similarly to WAS and NWAS, the quarterly values are obtained by using the annual coefficients from this equation with quarterly values of YP and the constant term.[23]

The four class variables, YAS_i, are obtained using the exogenous ratios,

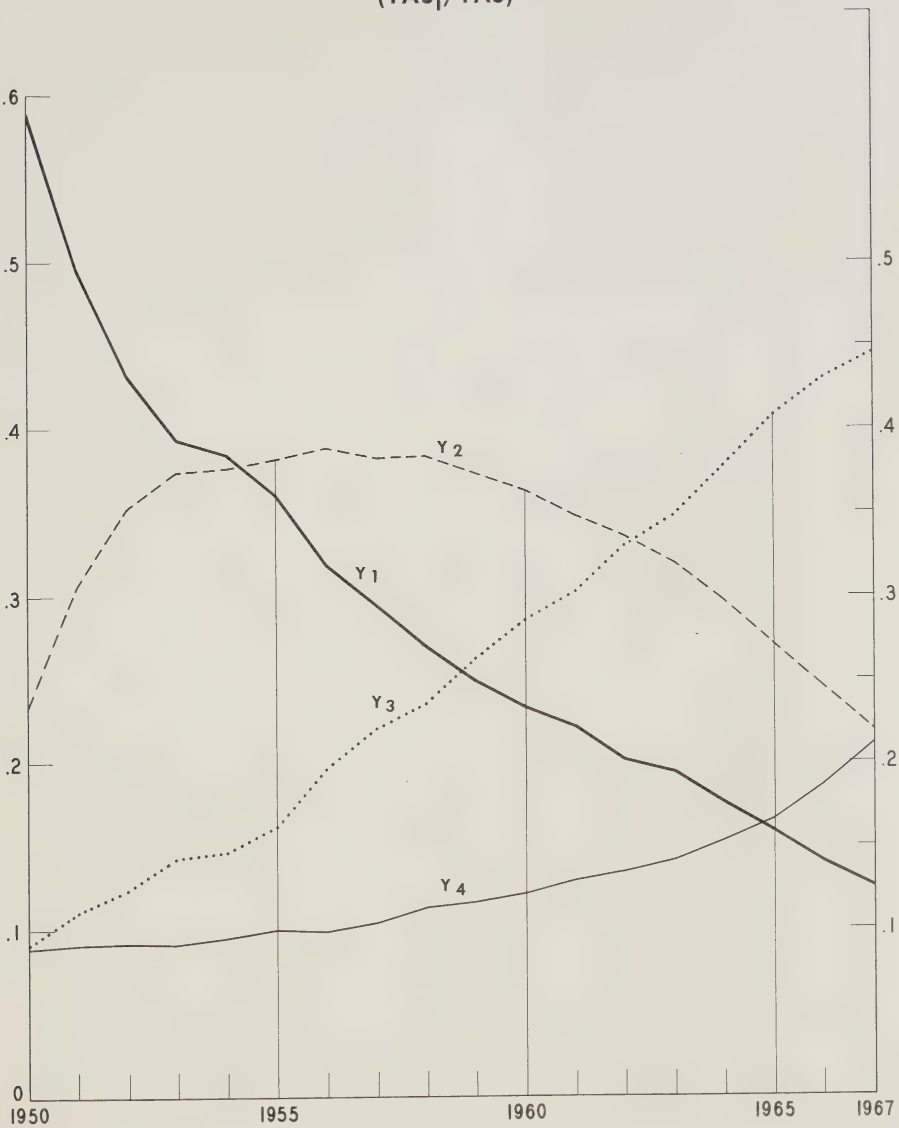
$$Y_i = YAS_i/YAS$$

derived from interpolating the annual series, calculated from the *Taxation Statistics* and shown in Chart 7. The Y_i are in every way similar to the other ratios of this sort discussed above. Classes 1 and 2 display the effect of the movement of taxpayers and income into and out of the respective groups, with Class 3 yet to level off. Three of the four ratios are used to obtain YAS_i according to equations (2.9) to (2.12).

[23]That is, the quarterly value of the annual constant term, which would be 493.69.

Chart 7

PROPORTION OF TOTAL ASSESSED INCOME IN EACH INCOME CLASS
(YAS_i/YAS)



C. Econometric Results

1. Model 1

1Q52-4Q65

$$TPS = \underset{(107.21)}{1.178}\ (2/3\ AW + 1/3\ AW_{t-1}) - .036\ Q1 \sum_{j=-1}^{-4} AW_{t+j} - .116\ Q2 \sum_{j=-2}^{-5} AW_{t+j} \qquad (1.2)$$

SEE = 21.1 $\qquad \bar{R}^2 = .979 \qquad$ D/W = 1.80

1Q52-4Q65

$$TPO = \underset{(29.93)}{.285}\ Q1 \sum_{j=-1}^{-4} ANW_{t+j} + \underset{(88.28)}{.841}\ Q2 \sum_{j=-2}^{-5} ANW_{t+j} + \underset{(29.81)}{.284}\ Q3 \sum_{j=-3}^{-6} ANW_{t+j} + \underset{(26.10)}{.249}\ Q4 \sum_{j=-4}^{-7} ANW_{t+j} \qquad (1.4)$$

SEE = 11.5 $\qquad \bar{R}^2 = .983 \qquad$ D/W = 1.38

If we combine the two equations to give TP, a residual analysis of the result yields a SEE of 23.1, indicating that much of the error in each equation is offsetting. Combining the equations thus may improve our chances of getting a good estimate of TP = TPS + TPO.

In equation (1.2) one would expect the sum of the coefficients to be approximately equal to 1, with a positive coefficient on the first term and negative on the two refund terms. The latter expectation is fully satisfied, but the sum of the coefficients is 1.03. The extra 3 per cent of accruals is attributable to

CORRECTION

Page 42, equation (1.2) is:

1Q52-4Q65

$$TPS = \underset{(107.21)}{1.178}\ (2/3\ AW + 1/3\ AW_{t-1})$$

$$- \underset{(6.84)}{.036}\ Q1 \sum_{j=-1}^{-4} AW_{t+j} - \underset{(21.51)}{.116}\ Q2 \sum_{j=-2}^{-5} AW_{t+j}$$

SEE = 21.1 $\bar{R}^2$ = .929 D/W = 1.80

an underestimate of AW because of discrepancies between the figures in the *Taxation Statistics*, upon which our independent variables are based, and the national accounts figures, which we are attempting to estimate. Chart 8 shows annual personal income tax collections as recorded in the *National Accounts*, *The Canada Gazette, Part I*[24] (which contains the budgetary figures issued monthly by the Department of Finance), and the *Taxation Statistics*.

The difference between the *National Accounts* and the budgetary figures results from Quebec tax collections. The difference between *Taxation Statistics* and the budgetary figures[25] is due to a problem of coverage. *Taxation Statistics* is based on a sample of total tax returns filed to the first of December of the year following the tax year. In aggregate, the number of returns analyzed equals about 6 per cent of the total. This sample is drawn from a population that falls short of the total number of taxpayers by under 1 per cent. The armed forces are not included in the sample, and the statistics do not reflect subsequent adjustments to the initial assessments. However, the overall effect of these exclusions on the population statistics is thought to be minimal. A more significant problem, which no doubt accounts for much of the understatement of tax collections in the *Taxation Statistics*, is the portion of income and tax collections not reported on tax returns. There is no measure of how much tax this represents, but in some cases it could be significant. As a result, our independent variables based on the *Taxation Statistics* are understated relative to the dependent variable based on national accounts data.[26]

A similar effect is observed in equation (1.4). One would expect the coefficients on the four quarterly liability terms to be .25 if there were no year-end adjustment payments. The average

[24]*The Canada Gazette, Part I*, issued weekly by The Queen's Printer for Canada. The budgetary figures are published subsequently in the *Public Accounts of Canada*.

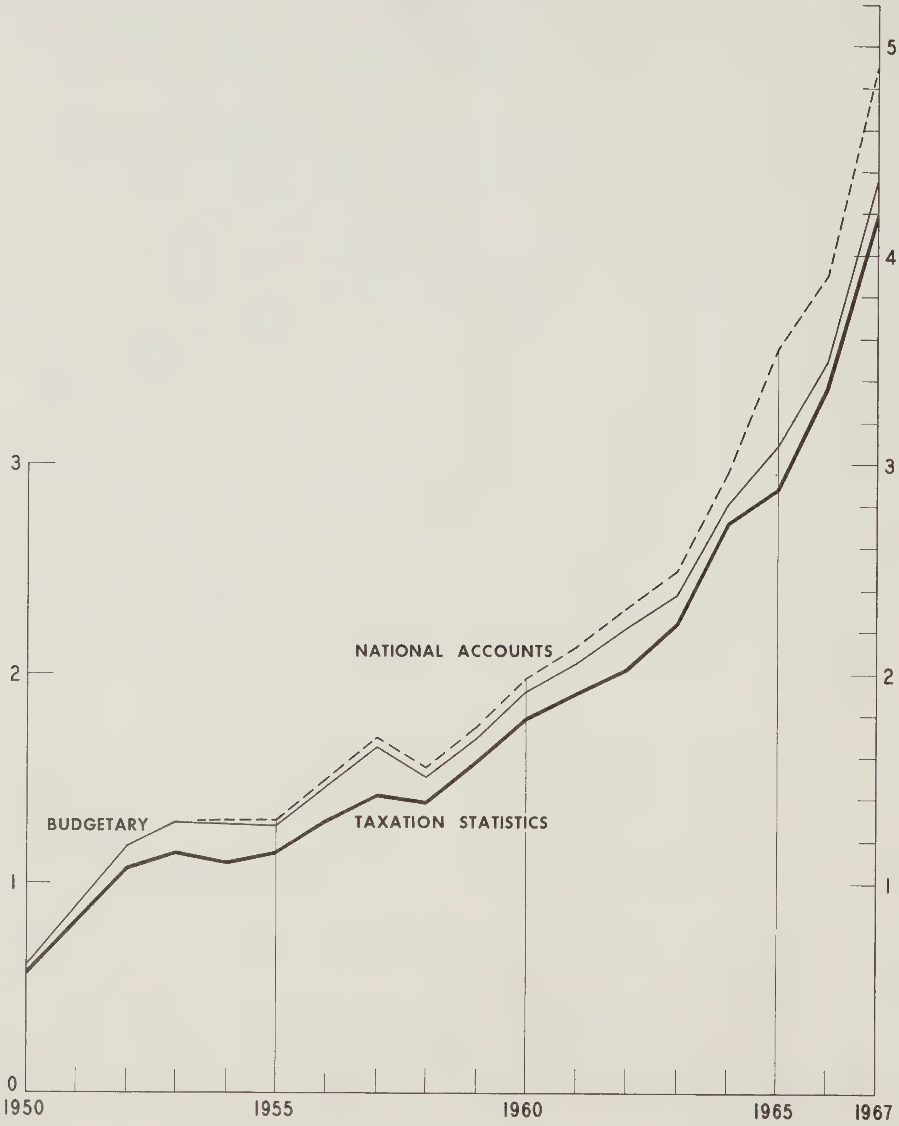
[25]The difference over this period is on average equal to 6 per cent of budgetary revenues.

[26]Indeed, the difference between the national accounts figures and the data derived from the *Taxation Statistics* averaged 12.7 per cent of the latter series over the 1950-1966 period. Coefficients that sum to about 1.13 are therefore to be expected.

Chart 8

TOTAL PERSONAL INCOME TAX COLLECTIONS ON THREE ACCOUNTING BASES

Billions of Dollars



value of the coefficients is substantially higher than .25, supporting our suspicion that accruals, based on the *Taxation Statistics*, are understated.

Two additional variables were tried in equation (1.4) in an attempt to capture the effects of large deviations from our assumption that all nonwage taxpayers base their quarterly instalments on the preceding year's actual liabilities, instead of on an estimate of the liabilities of the current year. The first of these variables, $(ANW_{-4} - ANW)^{+}$, has non-zero values only when the term is positive. $(ANW_{-4} - ANW)^{+}$ expresses the fact that when many individual nonwage incomes are declining more nonwage taxpayers will probably choose to base their tax payments on an estimate of the current year's income than when such incomes are rising, not (as we had assumed) on the previous year's accruals. If so equation (1.4), estimating tax payments in terms of the previous year's income, will be an overestimate of the tax actually payable. The coefficient on this variable should be negative and close to 1. As it turned out, the expression has non-zero values in all quarters of 1953 and 1954, in the second quarter of 1957, the fourth quarter of 1962, and the first quarter of 1963. The coefficient was negative whenever the variable was used in the equation, but always had a value much less than 1. This would seem to indicate that not all nonwage taxpayers switched between taxpaying options, either because they were unwilling or unable to make an accurate forecast of the current year's tax liability on which to base their tax payments. Gains would not have been large for many such people and we suspect that most of them regarded the benefits as not worth the effort. The term was never very significant and did little to improve our equation.

The other variable we tried represented an attempt to capture the nonlinear effect that cyclical changes in income have on the expected size of second-quarter nonwage adjustment payments. The variable used was

$$Q_2 \sum_{j=-2}^{-5} ANW_{t+j} \left[\sum_{j=-2}^{-5} (ANW_{t+j}) / \sum_{j=-6}^{-9} (ANW_{t+j}) \right]$$

The bracketed expression will vary around the value of 1 depending primarily upon whether nonwage incomes are rising (>1),

falling (<1), or remaining steady (=1). Of course, tax structure changes will also affect this ratio, possibly offsetting income changes. The usefulness of the term is reduced because of this possibility. However, if, with a given tax structure, accruals are rising over the previous year's accruals because of income changes, more quarterly instalments will be based on the preceding year's liabilities. This switch of taxpaying options will cause make-up payments in the following year to be higher than they otherwise would have been. The variable is designed to capture these changes in tax collections due to fluctuating make-up payments, concentrated primarily in the second quarter. Highly collinear with the main second-quarter term, the variable raises the standard error of the coefficient on this latter term quite significantly. We did not use the variable in our final model since it contributed little to the explanatory power of the equation within the data period.

2. Model 2

The estimated equation giving total tax collections, TP, directly is:

1Q52-4Q65

$$TP = \underset{(97.31)}{1.105}\,(2/3\ AY + 1/3\ AY_{t-1}) - \underset{(1.20)}{.007}\, Q_1 \sum_{j=-1}^{-4} AY_{t+j} + \underset{(7.41)}{.041}\, Q_2 \sum_{j=-2}^{-5} AY_{t+j} \qquad (2.2)$$

SEE = 27.9 $\qquad \bar{R}^2 = .972 \qquad$ D/W = 1.77

Here, as in equations (1.2) and (1.4), the coefficient on the accrual term is greater than the expected 1. The understatement of AY represented by the enlarged coefficient is approximately of the same magnitude as that obtained from AW and ANW, supporting the previous arguments.

The second-quarter adjustment term is positive, reflecting the preponderance of make-up payments on ANW relative to refunds

on AW in this quarter. The first-quarter refund term is negative, but the low coefficient and t-value suggest a near balance of refunds and make-up payments during this period.

The standard error of the estimate of TP is $23.1 million from *Model 1* and $27.9 million from *Model 2*, or, 2.8 per cent and 3.3 per cent of the average quarterly TP in 1965. Both models should predict well. Depending upon one's objectives, each model has its uses. Much of the improvement possible in both sets of equations will come from improved data. The basic specification is fairly straightforward as the tax structure is given quite explicitly in tax law. Additional experimentation must be undertaken to improve the specification of a number of the supporting equations, such as those for NT, YAS, WAS and NWAS, and, finally, exemptions could be made endogenous.

D. Models and Variables

1. *Model 1*

1.1 $$AW = \sum_{i=1}^{4} RW_i \left[WAS_i - (NTW_i)(\overline{WEX_i})\right] \quad (i=1,2,3,4)$$

1.2 $$TPS = 1.178\ (2/3\ AW + 1/3\ AW_{t-1}) - .036\ Q_1 \sum_{j=-1}^{-4} AW_{t+j}$$

$$- .116\ Q_2 \sum_{j=-2}^{-5} AW_{t+j}$$

1.3 $$ANW = \sum_{i=1}^{4} RW_i \left[NWAS_i - (NTNW_i)(\overline{NEX_i})\right] - RDC\ (DIVC)$$

$$(i=1,2,3,4)$$

1.4 $$TPO = .285\ Q_1 \sum_{j=-1}^{-4} ANW_{t+j} + .841\ Q_2 \sum_{j=-2}^{-5} ANW_{t+j}$$

$$+ .284\, Q_3 \sum_{j=-3}^{-6} ANW_{t+j} + .249\, Q_4 \sum_{j=-4}^{-7} ANW_{t+j}$$

1.5 $NT = .7930\,(NE) + 25.445\,(T_{1950})$

1.6 $WAS/WSSL = .4339\,(NU/NL) + .002\,(T_{1950}) + .8450$

1.7 $NWAS = .3555\,(NW)$

1.8 $NT_1 = N_1\,(NT)$

1.9 $NT_2 = N_2\,(NT)$

1.10 $NT_3 = N_3\,(NT)$

1.11 $NT_4 = NT - \sum_{i=1}^{3} NT_i$

1.12 $WAS_1 = W_1\,(WAS)$

1.13 $WAS_2 = W_2\,(WAS)$

1.14 $WAS_3 = W_3\,(WAS)$

1.15 $WAS_4 = WAS - \sum_{i=1}^{3} WAS_i$

1.16 $NWAS_1 = NW_1\,(NWAS)$

1.17 $NWAS_2 = NW_2\,(NWAS)$

1.18 $NWAS_3 = NW_3\,(NWAS)$

1.19 $NWAS_4 = NWAS - \sum_{i=1}^{3} NWAS_i$

1.20 $NTW_1 = NT_1\ [WAS_1/(WAS_1 + NWAS_1)]$

1.21 $NTW_2 = NT_2\ [WAS_2/(WAS_2 + NWAS_2)]$

1.22 $NTW_3 = NT_3\ [WAS_3/(WAS_3 + NWAS_3)]$

1.23 $NTW_4 = NT_4\ [WAS_4/(WAS_4 + NWAS_4)]$

1.24 $NTNW_1 = NT_1 - NTW_1$

1.25 $NTNW_2 = NT_2 - NTW_2$

1.26 $NTNW_3 = NT_3 - NTW_3$

1.27 $NTNW_4 = NT_4 - NTW_4$

2. Model 2

2.1 $AY = \sum_{i=1}^{4} RW_i\ [YAS_i - (NT_i)(\overline{YEX_i})] - RDC\ (DIVC)$

2.2 $TP = 1.105\ (2/3\ AY + 1/3\ AY_{t-1}) - .007\ Q_1 \sum_{j=-1}^{-4} AY_{t+j}$

$$+ .041\ Q_2 \sum_{j=-2}^{-5} AY_{t+j}$$

2.3 $NT = .7930\ (NE) + 25.445\ (T_{1950})$

2.4 $YAS = .8153\ (YP) - 493.69$

2.5 $NT_1 = N_1 (NT)$

2.6 $NT_2 = N_2 (NT)$

2.7 $NT_3 = N_3 (NT)$

2.8 $NT_4 = NT - \sum_{i=1}^{3} NT_i$

2.9 $YAS_1 = Y_1 (YAS)$

2.10 $YAS_2 = Y_2 (YAS)$

2.11 $YAS_3 = Y_3 (YAS)$

2.12 $YAS_4 = YAS - \sum_{i=1}^{3} YAS_i$

3. Variables and Data Sources

Much of the data is available on a tape created for the Bank of Canada Research Department Experimental Model (RDX1) and maintained in the Research Department of the Bank. Reference to this source will be in the form RDX 12345, where 12345 is the tape location of the particular series being discussed. The Research Department maintains two additional tapes, a master databank tape containing about 6,000 time series and a special tax tape containing some 700 series. Where variables are not entered on the RDX tape reference will be made to the databank tape or the tax tape in the form DB 12345 or TT 12345, respectively. Variables marked with an asterisk are discussed further in the data appendix, pages 138 to 162. All money magnitudes are in millions of current dollars, unless otherwise indicated.

Variables	Definition	Source
Endogenous		
ANW	Accrued tax liabilities on taxable nonwage personal income	Identity (1.3)
AW	Accrued tax liabilities on taxable wage income	Identity (1.1)
AY	Accrued tax liabilities on total taxable personal income	RDX 11600
NT	Total number of tax returns, taxable and non-taxable, annual values, units	(TT 6020 + TT 6030)
NT_i	Number of taxable and non-taxable returns in the i^{th} income class, calculated values, quarterly	RDX 11545-11548
$NTNW_i$	Number of nonwage tax returns in the i^{th} income class, calculated values, quarterly	See page 34.
NTW_i	Number of wage tax returns in the i^{th} income class, calculated values, quarterly	See page 35.
NWAS	Assessed nonwage personal income, annual values, thousands of dollars	(TT 6440 + TT 6450) - (TT 6050 + TT 6060)
$NWAS_i$	Assessed nonwage personal income in the i^{th} income class, calculated values, quarterly	NW_i (NWAS)

Variables	Definition	Source
Endogenous		
*TP	Total personal income tax collections, national accounts basis	RDX 11560
*TPO	Personal income tax collections; other payments, net of refunds	RDX 11024
*TPS	Personal income tax collections; deductions at source, net of refunds	RDX 11023
WAS	Assessed wage income, annual values, thousands of dollars	(TT 6050 + TT 6060)
WAS_i	Assessed wage income in the i^{th} income class, calculated values, quarterly	W_i (WAS)
YAS	Total assessed personal income, annual values, thousands of dollars	(TT 6440 + TT 6450)
YAS_i	Total assessed personal income in the i^{th} income class, calculated values, quarterly	RDX 11551-11554

Exogenous

DIVC	Dividends paid to Canadians by Canadian corporations (exogenous to government sector)	RDX 2406
$*\overline{EX}_i$	Average utilized exemptions and deductions claimed by taxpayers in the i^{th} income class, annual figure repeated in each quarter, thousands of dollars	RDX 11030-11033
$*N_i$	Proportion of total tax returns in the i^{th} income class	RDX 11302-11305
NE	Total employed (exogenous to government sector), millions of persons	RDX 11065
$*\overline{NEX}_i$	Average utilized exemptions and deductions claimed by taxpayers with nonwage income in the i^{th} income class. $\overline{NEX}_i$ equals average annual utilized exemptions ($\overline{EX}_i$) proportioned quarterly by assessed nonwage income	Data Appendix, pp. 144-148
NL	Total civilian labour force (exogenous to government sector), millions of persons	RDX 11141
NU	Total unemployed (exogenous to government sector), millions of persons	RDX 11063

Variables	Definition	Source
Exogenous		
NW	Total nonwage personal income, as per national accounts, equal to YP less WSSL (exogenous to government sector)	Derived from YP and WSSL
$*NW_i$	Proportion of assessed nonwage income in the i^{th} income class	RDX 11015-11018
*PE1	An adjusting ratio used to derive utilized exemptions in Class 1	RDX 11029
RDC	Rate of dividend tax credit, per cent/100	RDX 11006
$*RW_i$	Weighted average income tax rate for the i^{th} income class, per cent/100	RDX 11019-11022
SSPS	Social security and government pension contributions (exogenous to government sector)	(RDX 11285 + RDX 2178)
T_{1950}	Quarterly time trend (T = 1 in first quarter of 1950, 2 in second quarter, etc.)	
$*W_i$	Proportion of assessed wage income in the i^{th} income class	RDX 11011-11014

$*\overline{WEX}_i$	Average utilized exemptions and deductions claimed by taxpayers with wage income in the i^{th} income class. $\overline{WEX}_i$ equals average annual utilized exemptions ($\overline{EX}_i$) proportioned quarterly by assessed wage income	Data Appendix, pp. 144-148
WSSL	Total wages, salaries and supplementary labour income as per national accounts (exogenous to government sector)	RDX 224
$*Y_i$	Proportion of total assessed personal income in the i^{th} income class	RDX 11393-11395, 11398
$*\overline{YEX}_i$	Average utilized exemptions and deductions claimed by taxpayers in the i^{th} income class. $\overline{YEX}_i$ equals average annual exemptions ($\overline{EX}_i$) proportioned quarterly by assessed personal (i.e. wage plus nonwage) income, dollars	RDX 11556-11559
YP	Total personal income as per national accounts (exogenous to government sector)	RDX 240

2-1-2 CORPORATION INCOME TAX ACCRUALS

A. Total Corporation Income Tax Accruals

Unlike almost all other government tax revenues, corporation direct taxes are recorded in the *National Accounts* on an accrual basis. In this subsection we present four estimating equations for corporation income tax accruals. We constructed the first two equations, (2) and (2'), to estimate total corporation accruals as they appear in the *National Accounts* (TCA, RDX 1352); and the second two, (3) and (3'), to estimate TCA net of provincial logging and mining taxes (PLMT, RDX 11626). In section 2-3-2-6 we explain the equation that converts our accrual series to a collection basis. From our accrual and collection equations the cash-budget item can be derived. It consists of corporation taxes accrued but not collected.

In modelling corporation income tax accruals we followed the procedure used to explain all of our tax revenue series. We calculated a weighted tax rate and used the product of this rate with an appropriate base as the independent variable in the regression equation.

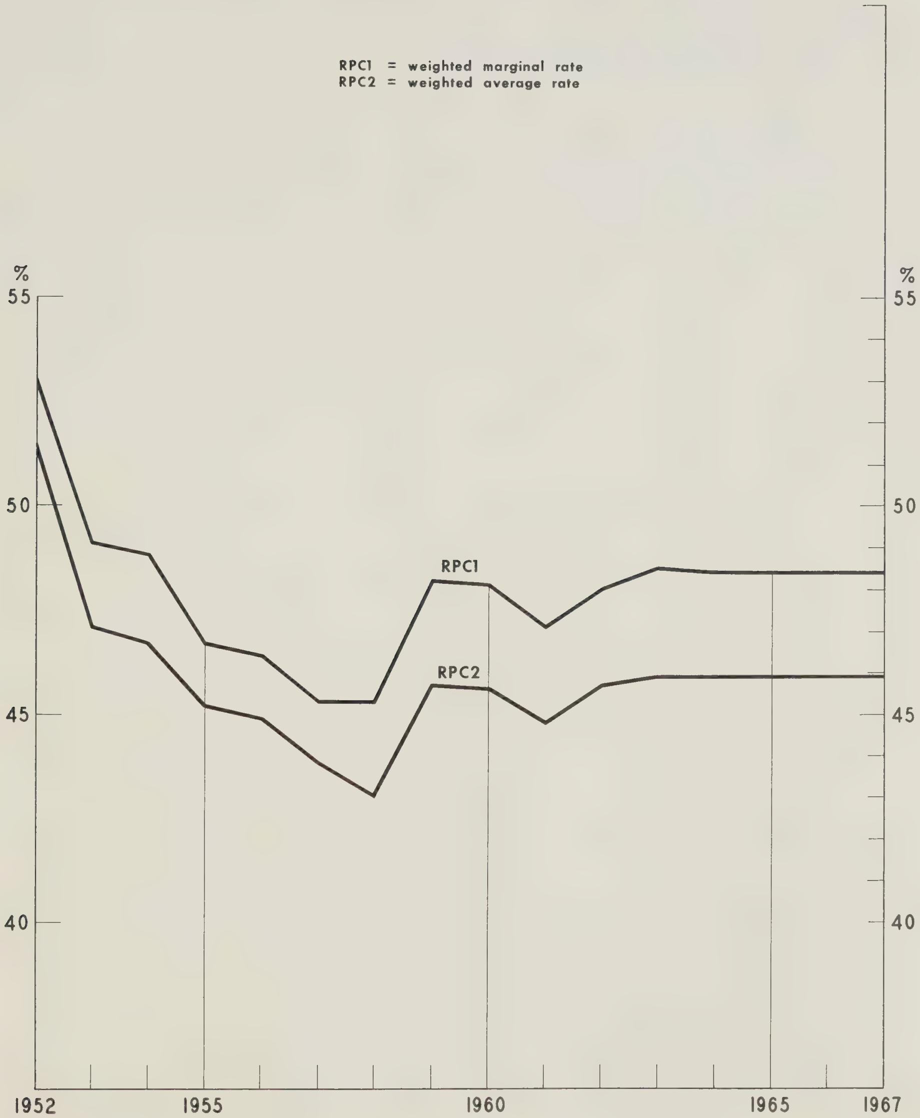
The weighted corporation tax rate is easier to calculate than that for the personal income tax, since there are only two marginal corporation rates at the federal level[27] and a single rate at the provincial level. We calculated two sets of weighted rates, RPC1 and RPC2, which include both federal and provincial levies. Computational methods and values for these rates are given in the data appendix. Chart 9 shows RPC1 and RPC2 from 1952 to 1967.[28] The difference between the two series is that RPC1 is a weighted marginal rate, assuming that all corporations taxed at the high rate pay that rate of tax on their total taxable income, while

[27]Corporations pay 21 per cent on their first $35,000 of taxable income plus 50 per cent on the amount over $35,000. These rates include a 3 per cent levy for the old age security tax. In addition corporations were subject to a 3 per cent surcharge in 1968 and 1969.

[28]1964 is the last year for which the tax data needed to derive our weighted rates are available. Rates shown for 1965, 1966 and 1967 are therefore estimates obtained by extrapolation.

Chart 9

WEIGHTED CORPORATION INCOME TAX RATES



RPC2 is a weighted average rate. One would expect, therefore, that the use of RPC1 would overstate accruals. Allowance was made for this by calculating as a separate variable (D3), the approximate amount by which TCA would be overstated, and by adding D3 to TCA in the regressions that use RPC1. Construction of D3 is outlined in the data appendix.

The base we used is taxable corporation profits (PCT) available from *Taxation Statistics, Part Two (Corporations)*.[29] Our values for PCT were generated endogenously using national accounts corporation profits (PC, RDX 226). PC, which is endogenous to RDX1, should be available from a comprehensive macro-model. Taxable profits was used as the base because it is more directly related to tax liabilities than is PC. National accounts profits include income that for tax purposes is not included in the tax base.[30] PC also is net of current year losses, while PCT excludes some prior year losses as well. Our available data for PCT on a calendar year basis end in 1963. The annual regression of PCT on PC and a time trend from 1950 to 1963 performed quite well as shown below.

1950-1963

$$PCT = \underset{(24.32)}{.7591}\ PC + \underset{(8.00)}{31.2671}\ T + \underset{(6.85)}{500.5346} \qquad (1)$$

$SEE = 27.63$ $\qquad \bar{R}^2 = .997$ $\qquad D/W = 1.98$

where T equals 1 in 1950, 2 in 1951, etc.

[29] *Taxation Statistics, Part Two (Corporations)* issued annually by the Department of National Revenue. See the 1966 volume (containing 1964 statistics) Historical Table 1A, p. 69, column 5. Taxation statistics for subsequent years appear in *Corporation Financial Statistics* and *Corporation Taxation Statistics* issued by D.B.S., catalogue nos. 61-207 and 61-208, respectively.

[30] These items include such tax deductions as: depletion allowances, provincial mining and logging taxes, provision for losses and additions to banks' inner reserves, and charitable contributions.

Quarterly estimates of PCT were obtained from the equation

$$PCT = .7591\ PC + 7.8168\ T + 125.1337 \qquad (1')$$

where PC is the quarterly series and T is now a step function equal to 1 in all quarters of 1950, 2 in all quarters of 1951, etc.

If the series for RPC1, RPC2 and D3 are calculated correctly one would expect a coefficient of 1 and a high $\overline{R}^2$ in the TCA equations, regardless of which of the two structures are used. The estimated equations appear below.

1Q52-4Q65

$$TCA + D3 = \underset{(245.5)}{.9816}\ RPC1\ (PCT) \qquad (2)$$

SEE = 12.58 $\qquad \overline{R}^2 = .982 \qquad$ D/W = 1.19

$$TCA = \underset{(231.1)}{.9855}\ RPC2\ (PCT) \qquad (2')$$

SEE = 12.79 $\qquad \overline{R}^2 = .979 \qquad$ D/W = 1.25

These results are encouraging. The fit is good although the pattern of the residuals is not satisfactory. The coefficient is slightly less than unity in both cases, but this may be so because certain classes of corporations are subject to special tax rates. For example in 1964 investment companies paid at the lower rate (21 per cent) on their entire taxable income and non-resident-owned investment companies paid at an 18 per cent rate. In addition electric, gas, or steam utilities were taxed at reduced rates on specified parts of their income. Our failure to take such special rate structures into account results in an overstatement of our weighted-rate series. As a final check on the TCA equations we used them to forecast quarterly corporation income tax accruals for 1966 and 1967. The results are shown in Table 3. Both equations forecast well, with equation (2') performing only marginally better than equation (2) in 1967.

Table 3

TOTAL CORPORATION INCOME TAX ACCRUALS 1966-1967
(Millions of dollars)

	Actual Values*	Forecast Values Equation (2)	Forecast Error	Forecast Values Equation (2')	Forecast Error
1966 Q1	462	502	+40	505	+43
2	626	614	-12	611	-15
3	559	531	-28	532	-27
4	605	587	-18	586	-19
Year	2,252	2,234	-18	2,234	-18
1967 Q1	441	464	+23	469	+28
2	604	585	-19	585	-19
3	555	555	0	556	+1
4	608	595	-13	594	-14
Year	2,208	2,199	-9	2,204	-4

* *National Accounts* — Quarterly, Table 5, line 4.

Table 4

TOTAL CORPORATION INCOME TAX ACCRUALS
LESS PROVINCIAL LOGGING AND MINING TAXES 1966-1967
(Millions of dollars)

	Actual Values*	Forecast Values Equation (3)	Forecast Error	Forecast Values Equation (3')	Forecast Error
1966 Q1	437	495	+58	497	+60
2	610	605	-5	602	-8
3	552	523	-29	524	-28
4	598	579	-19	577	-21
Year	2,197	2,202	+5	2,200	+3
1967 Q1	414	457	+43	462	+48
2	596	577	-19	577	-19
3	545	547	+2	548	+3
4	602	586	-16	585	-17
Year	2,157	2,167	+10	2,172	+15

* *National Accounts* — Quarterly, Table 5, line 4 minus PLMT (RDX 11626).

To explain corporation tax collections (2-3-2-6) and to disaggregate by level of government our corporation accrual series must be net of provincial logging and mining taxes, PLMT. Subtracting PLMT from TCA and reestimating equations (2) and (2') we get the following results:

1Q52-4Q65

$$TCA - PLMT + D3 = \underset{(195.6)}{.9679}\ RPC1\ (PCT) \qquad (3)$$

SEE = 15.57 $\qquad \bar{R}^2 = .973 \qquad$ D/W = 1.42

$$TCA - PLMT = \underset{(178.2)}{.9711}\ RPC2\ (PCT) \qquad (3')$$

SEE = 16.34 $\qquad \bar{R}^2 = .967 \qquad$ D/W = 1.56

The goodness of fit has decreased slightly although there has been some improvement in the pattern of the residuals. Excluding PLMT from TCA does not appear to worsen the forecasting ability of the equations to any large extent. The PLMT series is on a collection basis and most of the annual figure is concentrated in the first two quarters. Some experiments were made with quarterly dummies in an attempt to improve the performance of the equations but the results generally were less satisfactory than those from the equations presented. While more experiments are currently underway, at present the accrual equation used in RDX1 is equation (3') above.[31]

B. Federal Corporation Income Tax Accruals

We attempted to explain federal corporation accruals (FCA) in a manner analogous to our explanation of total corporation accruals. The results are presented in equations (4) and (4').

[31]The rate used in RDX1 is RPC2. However, since no other corporation tax rates appear in the model, RPC2 is entered simply as RPC (RDX 11007).

1Q52-4Q65

$$FCA + D3 = .9455 \text{ FRPC1 (PCT)} \quad (4)$$
$$(203.1)$$

SEE = 12.61 $\bar{R}^2$ = .954 D/W = 1.50

$$FCA = .9478 \text{ FRPC2 (PCT)} \quad (4')$$
$$(188.6)$$

SEE = 12.89 $\bar{R}^2$ = .946 D/W = 1.48

FRPC1 and FRPC2 are the weighted marginal and average federal rates of corporation tax. They are equal to RPC1 and RPC2 less the weighted average of federal abatement rates and any levies in excess of the abatement rate imposed by provincial governments. See data appendix pages 152-153 for values of FRPC1 and FRPC2.

In equations (4) and (4') the fits are good and the patterns of residuals satisfactory although the coefficients are disappointingly low, being about ten standard errors away from their expected values of unity. While the forecasting performance of these equations is satisfactory it is not nearly as good as that of the TCA equations. Equation (4) understates actual FCA by $53 million (3.12 per cent) in 1966 and $46 million (2.82 per cent) in 1967. Forecasts using equation (4') are also too low by $54 million in 1966 and by $41 million in 1967.

The problem involved, in attempting to estimate federal corporation tax accruals by using structural equations such as those outlined above, is that we do not know how accurately the federal accrual figures reported in the *National Accounts* reflect true federal accruals. The only source of quarterly tax accrual data available prior to publication of *Taxation Statistics* is the corporation profits survey.[32] Firms responding to this survey report only the quarter's additions to current liabilities for total corporation income taxes. Therefore, no source of data exists from which to build up a series for federal corporation tax accruals.

[32] *Corporation Profits* issued quarterly by D.B.S., catalogue no. 61-003.

In section 3-1-3-1 a rationale is presented for calculating provincial corporation tax accruals based on our a priori knowledge of the tax structure. If such a procedure is followed, we would obtain federal corporation accruals as a residual, denoted as FCAR. This series is presented in the data appendix on page 160. FCAR does not correspond to the national accounts series, FCA, but there is no reason why these two series should be identical.

We thus have two series for federal corporation tax accruals——FCA, which corresponds to the series in the *National Accounts* and which we estimate by equation (4) or (4'), and FCAR, which is the difference between the TCA series in the *National Accounts* and our theoretically constructed PCA series defined in section 3-1-3-1 below.[33] We present in section 2-3-2-6 two estimated equations for federal corporation tax collections, one based on FCA and the other based on FCAR.

C. Provincial Corporation Income Tax Accruals

Provincial corporation tax accruals are explained in detail in section 3-1-3-1.

2-1-3 NON-RESIDENT WITHHOLDING TAX

In deciding to include the withholding tax in our federal tax sector, we considered several factors. First, this tax is not a major source of revenue to the federal government——in 1966 it yielded $203 million or 2 per cent of total federal revenues, and only 1 per cent prior to major changes in 1960. Second, as a short-run policy instrument, the value of the tax is limited due to its international aspects and the treaty negotiations that must precede any short-run discretionary rate change or base changes. Even if a non-resident withholding tax were more flexible

[33]If we use the FCA series then provincial corporate accruals must be determined residually. We thus have a PCAR series as well as a PCA series and the following identities must hold:

$$TCA = FCA + PCAR$$

$$TCA = PCA + FCAR$$

for policy purposes, the relatively small amount of revenue involved implies a minimal impact on the economy. Over the longer run, however, major changes such as those initiated in 1960 will have some effect, and since a good estimating equation was not too difficult to find we decided to include it among the federal tax equations.

A withholding tax of 15 per cent (with some exceptions noted below) is levied on the gross Canadian income of non-residents received in the form of dividends, interest, estate or trust income, management fees, gross rents, royalties, and alimony. The withholding tax on film payments is 10 per cent. Except for a number of special rates and exemptions, which applied to some dividend and interest payments prior to the 1960 changes, the tax has changed very little during the postwar period. Before 1960 dividend payments by a wholly-owned subsidiary of a U.S. company were taxed at 5 per cent. Interest payments on bonds of, or guaranteed by, the federal government were exempted completely, as well as all interest payable in foreign exchange to non-residents. In 1960 the dividend tax rate applicable to U.S. subsidiaries was increased to 15 per cent and the main interest exemptions were cancelled. Various other exemptions and special rate categories give an effective rate of tax on this income of less than 15 per cent——in 1965 the average effective rate was about 12 per cent.[34]

No data were available with which to construct a weighted average of the various rates applied to each of the income components, so we used a constant 15 per cent rate for the entire estimating period. We obtained from the Department of National Revenue a detailed breakdown of the tax base for 1965 and 1966. This revealed that interest and dividends accounted for 81 per cent of the tax base in these two years, and if royalties were included the remainder amounted to less than 10 per cent. It seemed possible, therefore, that our tax base need be composed only of dividend and interest payments——in any event interest and

[34] In 1963 a 10 per cent rate on dividends paid by a company having a prescribed degree of Canadian ownership was introduced. Also certificates of exemption were issued to certain non-residents for interest on bonds and debentures payable after June 13. These changes were not significant during the period we used, but should be considered if the data period extends beyond 1965.

dividends are the sole published components of the withholding tax base. The time series of dividends paid to non-residents gross of the withholding tax (DIVF, RDX 227) is available from the *National Accounts*, while interest payments net of the tax (INT, DB 3716) can be obtained either from the *National Accounts* or from the balance of payments statistics.[35] To provide our tax base, the interest series was divided by the factor (1 - .15) and then added to DIVF. The use of a constant tax rate and a tax base restricted to interest and dividends means that the coefficient will be unlikely to take on the value of 1 as we would have expected if a weighted rate and the true base had been used. Instead, the coefficient will reflect the net effect of having a rate higher (<1) and a base lower (>1) than the true values.

The dependent variable, quarterly federal withholding tax revenues (TW), is composed of the budgetary collection series (DB 4006) shifted back one month to conform more closely to the flow of interest and dividends. This puts TW essentially on an accrual basis. A dummy variable is included to measure the effect of the 1960 changes. Thus

1Q54-4Q65

$$TW = \underset{(41.95)}{.8819}\,(X1) - \underset{(4.95)}{.1762}\,(D)(X1) \qquad (1)$$

SEE = 3.71 $\qquad \bar{R}^2 = .882 \qquad$ D/W = 1.72

where:

$X1 = .15\,[DIVF + INT/(1 - .15)]$

D = a dummy variable with a value of 1 in all quarters of 1954-1960, zero elsewhere.

The coefficient of .8819 on X1 shows that the effect of using a constant tax rate of 15 per cent, greater than the average effective rate, is more important than having a base equal to only 80 per cent of the actual base. Predictably the coefficient on the

[35] *Canadian Balance of International Payments and International Investment Position* issued annually by D.B.S., catalogue no. 67-201.

dummy variable is negative and gives some indication of how widespread the effects of the 1960 changes in the tax were.

We also ran the equation with a variable (X1)(T), where T is a time trend, to see if there had been any significant change over this period in the relationship of dividends and interest to the other components of the tax base. The variable was not significant and had very little effect on the equation, suggesting that there had been no major shift in the tax base components relative to the tax liabilities; hence we did not use it.

2-1-4-1 CUSTOMS DUTIES

If rates of import duty influence behaviour, there will be substitution over time in the pattern of imports with untaxed or lightly-taxed items substituted for relatively higher-tariff goods. If trade-flow statistics are not divided into categories corresponding to different tariff rates, it will be difficult to obtain a weighted average tariff rate that remains accurate when one type of good is substituted for another. We are therefore trying to obtain trade statistics that correspond as closely as possible to the duty categories. In the meantime, since the meantime may be a long time, we have developed for use in macro-models approximate relationships, which we offer with misgivings.

In RDX1 all taxes and government revenues are in current dollars, while all private expenditure is in constant dollars. Since current-dollar merchandise imports are the base for import duties, our equation must use constant-dollar merchandise imports (MG, RDX 9147) multiplied by the implicit price deflator for these imports (PMG, RDX 9145). We used only imports of goods because tariffs do not apply to service imports.

Three equations are presented. The first is a simple regression of customs duties on current-dollar imports, a specification that is only appropriate when the weighted average rate of import duty has been constant over the data period. Our first specification also ignores the effects of the 1962-1963 import surcharges.

1Q50-4Q65

$$TCUS = \underset{(78.9)}{.090} \ (MG)(PMG) \qquad (1)$$

SEE = 12.6 $\bar{R}^2$ = .812 D/W = .486

where:

TCUS = import duties (RDX 2157)

MG = imports of goods, 1957$

PMG = implicit price deflator for current $ MG, 1957=1

The coefficient .090 tells us just what we could have discovered by dividing the mean of TCUS by the mean of (MG)(PMG), that the average rate of duty over the whole period was 9 per cent.

In calculating equation (2) we adjusted for the impact of the 1962-1963 surcharges. This was done by constructing a variable SUR (RDX 11010), the weighted average rate of surcharge with weights based on the structure of imports just before the surcharge was introduced. We used this variable multiplicatively with (MG) (PMG) expecting a coefficient of approximately 1 if no substitution of unsurcharged for surcharged goods occurred during the surcharge period.

1Q50-4Q65

$$TCUS = \underset{(88.3)}{.089} \ (MG)(PMG) + \underset{(4.9)}{1.035} \ (SUR)(MG)(PMG) \qquad (2)$$

SEE = 10.9 $\bar{R}^2$ = .862 D/W = .327

The coefficient of 1.035 on the surcharge variable indicates that no significant substitution against the surcharged goods occurred during the surcharge period. The Durbin/Watson statistic reflects a string of positive residuals from 4Q51 to 4Q60, and primarily negative residuals at the end of the data period. Negative residuals are so predominant at the end that the equation overestimates TCUS by an average of 15 per cent in 1965. Clearly the weighted

average rate of duty has been declining throughout the period, either because of statutory rate changes (which were not large) or substitution of lightly-taxed for heavily-taxed items in the import mix.

Since the forecasting properties of the linear equation, equation (2), with an assumed constant duty rate are so unsatisfactory, we developed an alternative that should forecast much better in the short term. This third equation contains a quadratic term in imports. If the quadratic term receives its expected negative sign, then the resulting equation takes account of continuous substitution against the highly-taxed items. The equation also contains a first-quarter term, proportional to imports, intended to capture the apparent first-quarter bulge in lightly-taxed imports.

1Q52-4Q65

$$\begin{aligned} TCUS = {} & \underset{(61.1)}{.1201}\ (MG)(PMG) - \underset{(16.2)}{.000019}\ [(MG)(PMG)]^2 \\ & + \underset{(10.8)}{.9876}\ (SUR)(MG)(PMG) - \underset{(4.1)}{.0046}\ Q1\ (MG)(PMG) \end{aligned} \tag{3}$$

SEE = 4.69 $\bar{R}^2$ = .963 D/W = 1.04

Equation (3), which is employed in RDX1, has a markedly better fit and much less autocorrelation of its residuals than has equation (2). The danger with equation (3), of course, is that it will produce ridiculous results if extrapolated far enough beyond the estimation period. Estimated customs duties would become negative by the time constant-dollar imports of goods reached $6,500 million. Either the equation has to be reestimated every year (and even then only used for short-term forecasting) or an adequate, weighted tariff-rate variable must be constructed. In the meantime, equation (3) will have to do.

2-1-4-2 MANUFACTURERS' SALES TAX

Until 1963, the sales tax rate of 11 per cent applied to all non-exempt goods. The primary exemptions were most foods, fuels, construction materials, machinery and equipment used in the production of goods, and materials incorporated into manufactured goods. The June 13, 1963 budget proposed the removal, by stages, of the exemption for construction materials and machinery and equipment. The rate on these items was set at 4 per cent from June 14, 1963 to March 31, 1964, 8 per cent until December 31, 1964, and at the full 11 per cent thereafter. The fall budget of 1966 raised the regular rate from 11 to 12 per cent from January 1, 1967, but left at 11 per cent the rate applicable to construction materials and machinery and equipment. This budget proposed the complete removal, in stages, of the tax on production machinery and equipment. The rate on these items was reduced from 11 to 6 per cent on April 1, 1967, and became zero on June 2, 1967.

Our forecasting equation should therefore have separate variables for each of three major categories of expenditure now treated differently under the manufacturers' sales tax. In making our estimation, however, we have added together the terms for construction and for machinery and equipment, since the investment variables are strongly collinear and during the fitting period (we used data up to 4Q65) both types of investment received the same tax treatment.

If the forecasting equation is reestimated using data from subsequent years, it should be possible to split the two types of investment now treated separately under the sales tax. Our present equation is based on a weighted average of construction expenditures and machinery and equipment expenditures as the investment variable, and the sum of consumer expenditures on durables and non-durables as the general consumer expenditure variable. The relative weighting of construction and machinery and equipment in the investment variable is 42:100, based on a Dominion Bureau of Statistics (D.B.S.) estimate of the proportion of total construction expenditures comprising taxable materials.

Our equation is thus

1Q55-4Q65

$$TS = \underset{(74.1)}{.6327}\ (RSC)[(CD + CND)(PGNE)] + \underset{(9.9)}{.5482}\ [(RSIM)(IME)(PGNE)$$

$$+ .42\ (RSIR)(INRC + IRC)(PGNE)] \qquad (1)$$

SEE = 19.29 $\bar{R}^2$ = .943 D/W = 1.66

where:

TS = federal sales tax collections (RDX 11270)

CD = consumer expenditure on durables, 1957$ (RDX 141)

CND = consumer expenditure on non-durables, 1957$ (RDX 140)

IME = investment in machinery and equipment, 1957$ (RDX 11306)

INRC = investment in non-residential construction, 1957$ (RDX 11307)

IRC = investment in residential construction, 1957$ (RDX 145)

PGNE = private GNE deflator, 1957 = 1 (RDX 9153)

RSC = basic sales tax rate, applicable to consumer durable and non-durable expenditure (RDX 11025)

RSIM = tax rate applicable to machinery and equipment (RDX 11620)

RSIR = tax rate applicable to construction materials and building supplies (RDX 11621)

The coefficients on both variables should be less than 1, since the federal sales tax is levied on the manufacturers' sale price,

while (CD + CND)(PGNE) is the value of final consumer expenditure (including federal and retail sales taxes plus retailers' margins), and the three investment series measure the total value of work put in place (including manufacturers' sales taxes and installation costs). In addition, a number of tax-exempt items are included in the expenditure series.

2-1-4-4 EXCISE DUTIES

We shall present here two equations, the first intended to picture the structure of the tax with some accuracy, and the second designed for use in a macro-model. Equation (2) does not contain the exact base for the excise duties, but tries to make use of an appropriate proxy series. Equation (1) uses constant-dollar expenditures on tobacco products and alcoholic beverages (both inflated by the consumer non-durable deflator) as independent variables, while equation (2) uses the sum of consumer expenditures on durables and non-durables inflated by their appropriate price indices. The first equation is fitted over a shorter time period than the second since the quarterly expenditure series, disaggregated by commodity, is available only from 1956.

1Q56-4Q65

$$\underset{}{TEX} = \underset{(4.9)}{.165}\ BOOZE\ (PND) + \underset{(6.1)}{.283}\ BUTTS\ (PND) \qquad (1)$$

SEE = 5.30 $\qquad \bar{R}^2 = .902 \qquad$ D/W = 2.60

1Q52-4Q65

$$TEX = \underset{(109.2)}{.02299}\ [CD\ (PD) + CND\ (PND)] \qquad (2)$$

SEE = 5.60 $\qquad \bar{R}^2 = .920 \qquad$ D/W = 1.78

where:

TEX = excise duties (RDX 2158)

CD = consumer expenditure on durable goods, 1957$ (RDX 141)

CND = consumer expenditure on non-durable goods, 1957$ (RDX 140)

BOOZE = consumer expenditure on alcoholic beverages, 1957$ (DB 2310)

BUTTS = consumer expenditure on tobacco products, 1957$ (DB 2309)

PD = implicit price index of consumer durable expenditure, 1957 = 1 (RDX 11384)

PND = implicit price index of consumer non-durable expenditure, 1957 = 1 (RDX 11423)

The additional structural detail of the first equation does not achieve a high payoff in terms of goodness of fit, presumably because the detailed expenditure data are not very reliable. Equation (2), based on total consumer expenditure on durables plus non-durables, fits well and apparently has reasonable error properties. It is used in RDX1. If excise duties were increased enough to shift consumption away from the excised goods, the straightforward use of equation (2) would naturally be dangerous.

2-3-2-6 CORPORATION INCOME TAXES ACCRUED BUT NOT COLLECTED

Equations for total corporation tax accruals (TCA)[36] and federal corporation tax accruals (FCA) were presented in section 2-1-2. To determine corporation taxes accrued but not collected, we require equations to explain corporation tax collections, both total (TCC)[36] and federal (FCC). Then, by subtracting TCC from TCA and FCC from FCA one can determine the items required for the cash budgets of the federal and provincial governments.

[36]Both of these series are net of provincial logging and mining taxes (PLMT, RDX 11626).

A. Total Corporation Income Tax Collections

In constructing the collection equation several features of the tax law have to be considered. The 'taxation year' of a corporation coincides with its fiscal year. During the taxation year a corporation pays taxes in regular instalments, each instalment being a prescribed amount of either (1) the actual accrued tax liability of the corporation for the preceding taxation year or (2) an estimate of accrued tax liability in the current taxation year. After paying the required number of instalment payments, the corporation must make adjustment payments based on the difference between actual liabilities incurred in the taxation year in question and total tax paid on account for that year.

Although the basic rules for payment of taxes have not changed, since 1962 they have often been amended. These amendments have altered the timing of payments and the fraction of tax liabilities due in each instalment. Table 5 is a simplified exposition of the number, amount and timing of instalment and adjustment payments made by corporations as amendments to the rules of payment have occurred.

Tax payments are usually made on the last business day of the month in which they are due and, as a result, are recorded as tax collections in the following month. Our equation must take account of this recording lag.

The collection equation is constructed on the assumptions that all corporations have fiscal years ending on December 31,[37] that the figures recorded as tax accruals in the *National Accounts* actually represent a corporation's tax liability for the relevant taxation year, and that all firms make their interim payments on the basis of their actual taxes in the preceding taxation year rather than on their estimate of their tax liability for the current year.

[37]Because the fiscal years of the chartered banks end on October 31, we constructed an equation to deal separately with tax collections from banks and other corporations. Since the split did little to improve the explanatory power of the model, we present here only the aggregate model based on the assumption that all fiscal years end on December 31.

Table 5

SCHEDULE OF INCOME TAX INSTALMENT PAYMENTS BY CORPORATIONS

	Months of First Taxation Year												Months of Second Taxation Year					
Taxation Year Ending:	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	1st	2nd	3rd	4th	5th	6th
Before Dec. 1, 1963	-	-	-	-	-	-	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/3*	1/3*	1/3*
Dec. 1, 1963 to Nov. 30, 1964	-	-	-	-	-	-	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/2*	1/2*	-
Dec. 1, 1964 to Nov. 30, 1965	-	-	-	-	-	1/11	1/11	1/11	1/11	1/11	1/11	1/11	1/11	1/11	1/2*	1/2*	-	-
Dec. 1, 1965 to Nov. 30, 1968	-	-	-	-	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/2*	1/2*	-	-
Dec. 1, 1968 to Nov. 30, 1969	-	-	-	-	-	1/5	-	1/5	-	1/5	-	1/5	-	1/5	*	-	-	-
Dec. 1, 1969 to Nov. 30, 1970	-	-	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	-	-	*	-	-	-
After Dec. 1, 1970	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	-	-	*	-	-	-

* Adjustment Payment - balance of tax is due with final adjustment payment.

Source: *Canadian Master Tax Guide*, published by Commerce Clearing House Canadian Limited, various issues.

The detailed collection equation from 1953 to 1971 is presented in Table 6. This equation is extremely complex due to changes that have occurred in the legislation since 1963; and an examination of the terms separately, quarter by quarter, is helpful. As an example of the procedure we employed, consider the term for the second quarter of 1965. The assumption is that all corporations have fiscal years ending December 31, 1965. Thus their payments schedule would be that shown in the fourth row of Table 5. In the second quarter of 1965 corporations pay two-twelfths of liabilities accrued in 1964. Because of the recording lag, however, only one-half of their payment is entered as having been made in the second quarter. Thus we get the first term of our sum:

$$1/12 \left[\sum_{-2}^{-5} TCA \right]$$

The second term in the sum takes account of the adjustment payments made in 1965 for taxes paid in 1964. One-half of the difference between accrued liabilities in 1964 and payments in 1964 (which were based on accrued liabilities in 1963) is to be paid in March and the other half in April 1965. Because of the recording lag both of these payments are entered as collections in the second quarter of 1965. Therefore the expression for the adjustment payments is:

$$\sum_{-2}^{-5} TCA - \sum_{-1}^{-3} TCC$$

The summations appearing in the other cells of Table 6 are derived in the same way.

We used our accrual series, appropriate quarterly dummies and the relevant algebraic transformations from Table 6, to construct the variables X1, X2, X3 and X4, from 1953 to 1967. Each of these variables represents the appropriate quarterly term of the collection equation, for example:

Table 6

QUARTERLY TERMS OF TOTAL CORPORATION INCOME TAX COLLECTION EQUATION

Calendar Year*	Q1	Q2	Q3	Q4
1952 to 1963	$1/4[\sum_{-5}^{-8} TCA]$	$1/12[\sum_{-6}^{-9} TCA] + 2/3[\sum_{-2}^{-5} TCA - (\sum_{-1}^{-2} TCC + 1/4 \sum_{-6}^{-9} TCA)]$	$1/6[\sum_{-3}^{-6} TCA] + [\sum_{-3}^{-6} TCA - (\sum_{-1}^{-3} TCC + 1/6 \sum_{-7}^{-10} TCA)]$	$1/4[\sum_{-4}^{-7} TCA]$
1964	$1/4[\sum_{-5}^{-8} TCA]$	$1/12[\sum_{-6}^{-9} TCA] + [\sum_{-2}^{-5} TCA - (\sum_{-1}^{-2} TCC + 1/4 \sum_{-6}^{-9} TCA)]$	$3/11[\sum_{-3}^{-6} TCA]$	$3/11[\sum_{-4}^{-7} TCA]$
1965	$3/11[\sum_{-5}^{-8} TCA]$	$1/12[\sum_{-2}^{-5} TCA] + [\sum_{-2}^{-5} TCA - \sum_{-1}^{-3} TCC]$	$1/4[\sum_{-3}^{-6} TCA]$	$1/4[\sum_{-4}^{-7} TCA]$
1966 to 1967	$1/4[\sum_{-5}^{-8} TCA]$	$1/12[\sum_{-2}^{-5} TCA] + [\sum_{-2}^{-5} TCA - (\sum_{-1}^{-3} TCC + 1/12 \sum_{-6}^{-9} TCA)]$	$1/4[\sum_{-3}^{-6} TCA]$	$1/4[\sum_{-4}^{-7} TCA]$
1968	$1/4[\sum_{-5}^{-8} TCA]$	$[\sum_{-2}^{-5} TCA - (\sum_{-1}^{-3} TCC + 1/12 \sum_{-6}^{-9} TCA)]$	$2/5[\sum_{-3}^{-6} TCA]$	$1/5[\sum_{-4}^{-7} TCA]$
1969	$2/5[\sum_{-5}^{-8} TCA]$	$3/10[\sum_{-2}^{-5} TCA] + [\sum_{-2}^{-5} TCA - \sum_{-1}^{-3} TCC]$	$3/10[\sum_{-3}^{-6} TCA]$	$3/10[\sum_{-4}^{-7} TCA]$
1970	$1/10[\sum_{-5}^{-8} TCA] + 1/6[\sum_{-1}^{-4} TCA]$	$1/4[\sum_{-2}^{-5} TCA] + [\sum_{-2}^{-5} TCA - (\sum_{-2}^{-3} TCC + 2/5 \sum_{-6}^{-9} TCA)]$	$1/4[\sum_{-3}^{-6} TCA]$	$1/4[\sum_{-4}^{-7} TCA]$
1971 and beyond	$1/12[\sum_{-5}^{-8} TCA] + 1/6[\sum_{-1}^{-4} TCA]$	$1/4[\sum_{-2}^{-5} TCA] + [\sum_{-2}^{-5} TCA - (\sum_{-2}^{-3} TCC + 1/2 \sum_{-6}^{-9} TCA)]$	$1/4[\sum_{-3}^{-6} TCA]$	$1/4[\sum_{-4}^{-7} TCA]$

* Coincides with taxation year, by assumption.

$$X4_{1953-1967} = Q4\left[\tfrac{1}{4}\left(\sum_{-4}^{-7} TCA\right)\right] D1 + Q4\left[\tfrac{1}{4}\left(\sum_{-4}^{-7} TCA\right)\right](D1)(D2)$$

where:

D1 = 1 from 1Q53 to 4Q67, zero elsewhere

D2 = 12/11 in 4Q64, zero elsewhere

Fitting the equation to quarterly accrual and collection data for the 1953-1965 period yielded the following result:

1Q53-4Q65

$$\underset{}{TCC} = \underset{(50.7)}{1.0064\ X1} + \underset{(61.2)}{1.0125\ X2} + \underset{(55.2)}{1.0667\ X3} + \underset{(51.3)}{.9808\ X4} \quad (1)$$

SEE = 25.92 $\quad\quad$ $\overline{R}^2$ = .916 $\quad\quad$ D/W = 1.16

Coefficients are all close to their expected value of unity. The equation was used to forecast total corporation tax collections for 1966 and 1967. We present the results in Table 7. The performance of the equation is quite satisfactory except for the second quarter of 1967. If in 1966 corporations had switched the base on which instalment payments are calculated from the prior year's accruals to the current year's estimated liabilities, then we would expect to get an overestimate in the third and fourth quarters of 1966 and the first quarter of 1967, and an underestimate in the second quarter of 1967. This is the pattern we observe in the forecast period. We have no direct evidence that corporations did in fact make this switch in their payment practices, but corporation profits in 1966 declined from their 1965 levels, particularly in the third and fourth quarters.[38] An expected decline in corporation profits would provide a rationale for switching the base on which instalment payments are calculated in the manner described above.

[38]Corporation profits in 1966 were $5,145 million, down from $5,199 million in 1965. In the second half of 1966 profits declined by $160 million from their level in the second half of 1965.

Table 7

TOTAL CORPORATION INCOME TAX COLLECTIONS
LESS PROVINCIAL LOGGING AND MINING TAXES 1966-1967
(Millions of dollars)

	Actual Values*	Forecast Values	Forecast Error
1966 Q1	516	506	-10
2	671	641	-30
3	549	581	+32
4	508	534	+26
Year	2,244	2,262	+18
1967 Q1	522	548	+26
2	721	627	-94
3	575	586	+11
4	548	539	-9
Year	2,366	2,300	-66

* *National Accounts* — Quarterly, Table 5, line 6 plus line 8 minus PLMT (RDX 11626).

Table 8

FEDERAL CORPORATION INCOME TAX COLLECTIONS 1966-1967
(Millions of dollars)

	Actual Values*	Forecast Values	Forecast Error
1966 Q1	398	392	-6
2	528	514	-14
3	409	436	+27
4	392	405	+13
Year	1,727	1,747	+20
1967 Q1	400	425	+25
2	569	513	-56
3	423	442	+19
4	413	410	-3
Year	1,805	1,790	-15

* *National Accounts* — Quarterly, Table 5, line 6.

B. Federal Corporation Income Tax Collections

Federal corporation tax collections (FCC) are explained by an equation exactly analogous to that in Table 6, except that federal corporation tax accruals (FCA, explained in section 2-1-2) are substituted for total accruals. The fitted result is:

1Q53-4Q65

$$\underset{}{FCC} = \underset{(45.4)}{1.0139\ X1} + \underset{(53.1)}{1.0323\ X2} + \underset{(46.8)}{1.0417\ X3} + \underset{(44.3)}{.9667\ X4} \qquad (2)$$

SEE = 24.98 $\bar{R}^2$ = .827 D/W = 1.40

Again, the fit is good (though not as good as that of the equation for total collections) and the coefficients are reasonably close to their expected value of unity. The 1966 and 1967 forecasts are presented in Table 8. The forecast error in 1967 is much lower than the error obtained from the total forecasting equation, equation (1); but the pattern of overestimation, in the third and fourth quarters of 1966 and the first quarter of 1967, followed by underestimation in the second quarter of 1967, is again apparent.

In section 2-1-2 above we pointed out that the federal accrual figures in the *National Accounts* were not based on reports from taxpayers. We developed a separate series for federal accruals, denoted as FCAR and listed in the data appendix on page 160. Our equation for federal tax collections was reestimated, using the FCAR series rather than the national accounts series, FCA.

1Q53-4Q65

$$FCC = \underset{(32.7)}{.9700\ X1} + \underset{(38.3)}{.9501\ X2} + \underset{(33.5)}{.8856\ X3} + \underset{(31.9)}{.9268\ X4} \qquad (2')$$

SEE = 34.61 $\bar{R}^2$ = .668 D/W = .95

Although the coefficients are still fairly close to unity, the overall fit of the equation is quite poor and the low Durbin/

Watson statistic indicates that the residuals are serially correlated. Assuming that the equation is theoretically correct, one would expect a much better fit. The poor results indicate that the FCAR series may not reflect true federal corporation tax liabilities as accurately as the national accounts series does.

C. Total and Federal Tax Accruals Minus Collections

These items are obtained by subtracting the appropriate collection series from the corresponding accrual series.

PART 3 FEDERAL TRANSFER PAYMENTS

Coverage of the transfer payments sector of the federal government submodel is incomplete. Only transfers to persons are included, and even within this category several small classes of transfers, reported separately in the *National Accounts*, are omitted. In part this lack of coverage is due to a shortage of time and effort input——certain other sectors of RDX1 were given higher priority. As research on the government sector advances and the structure of RDX increases in scope, further classes of transfer payments may be covered. But there are some transfers that we have no intention of including since their analysis would lead neither to structural information nor to predictive power.

In the first place, numerous programs are relatively trivial in scope. This is particularly true of the many transfers to business and agriculture, some of which involve no more than a few million dollars on a quarterly basis. From the viewpoint of recipients or of the overall effectiveness of government operations these amounts are, of course, significant. But, in the context of an aggregate model, analysis of such relatively small flows is unrewarding. Nor can we explain the total of all transfers to business treated as a lump sum because the resulting heterogeneous mix of policy parameters and exogenous variables in any such aggregate would make explanation of its behaviour meaningless. This size criterion also applies to programs currently in their terminal stages, such as the variety of war-associated transfers reported in the *National Accounts*, now, with two notable exceptions, of historical interest only.

Second, a problem arises when the exogenous variables in any analytic explanation of a transfer item are exogenous to the model as a whole and not susceptible to reliable projection. In a tax function the tax base is exogenous to the government sector yet endogenous to the entire model. In the old age pension equation the eligible population is exogenous to the model as a whole yet can be predicted into the middle-run future with reasonable certainty. But in the agricultural sector many transfers depend on the notoriously uncertain yields of the wide variety of crops produced. These exogenous variables may shift substantially

from year to year owing to the vagaries of the weather so that a highly variable subsidy, based on a highly variable set of output measures, interacts with a complicated set of parameters such as floor prices, storage costs, premiums, etc. Since the total impact of the program is unpredictable, elaborate dissection of its internal structure seems clearly unprofitable. Admittedly, we cannot then assess directly the impact of a change in agricultural policy directly in our model, but approximate adjustments to an exogenous agricultural transfers factor would probably yield results just as good as those obtainable from a fitted model.

Third, we excluded transfer programs that are currently in a state of flux because of recent establishment or major overhaul. The whole structure of such programs may shift from year to year. This problem occurs in the case of transfers to other levels of government, because many of these payments may be entirely renegotiated at relatively frequent intervals. Econometric analysis of time-series data requires the assumption that at least some aspects of a structural relation remain constant over time. If programs receive major overhauls in structure and parameters every few years, time-series analysis is clearly an inappropriate way of modelling their impact. Thus the behaviour of statutory grants and payments under tax-sharing agreements, health and welfare payments, technical and vocational training financing, all represent programs that do not provide enough historical experience of operation within a constant structure to be amenable to time-series analysis.

The transfers modelled, while representing a minority of all programs, still account for a large portion of the dollar volume of federal transfer payments. As shown in Table 9 federal transfers in 1965 totalled \$5,141 million. Of these, our equations cover \$2,190 million in transfers to persons and \$1,052 million in interest on the federal public debt, for a total of \$3,242 million or 63 per cent of all federal transfers. The bulk of the remaining 37 per cent is concentrated in transfers to other levels of government, a sector that will eventually be analyzed in conjunction with a disaggregated model of the provincial and municipal government sectors.

The transfer programs analyzed in this paper may be divided into three categories. In the first category are programs cover-

Table 9

TOTAL FEDERAL GOVERNMENT TRANSFER PAYMENTS
(Millions of dollars)

Index Code No.			1965 Transfer Payments
2-2-3	Transfers to persons		2,312
	Modelled	2,190	
	Excluded	122	
2-2-4	Interest on the federal public debt		1,052
2-2-5	Transfers to business and agriculture		343
2-2-6	Transfers to other levels of government		1,434
	Total		5,141

Source: *National Accounts* — Annual

ing transfers bound to specific revenue sources, and so entering the federal budget on both sides. It is clearly appropriate to treat these revenue and expenditure equations as parts of a single problem to be analyzed in a sub-submodel. In this category we have the Unemployment Insurance Fund and the (public service) Superannuation Account in the Consolidated Revenue Fund. The same treatment was not adopted for old age pensions because revenues of the Old Age Security Fund, from which pensions are formally paid, are raised through supplements to the personal income tax, the corporation income tax and the manufacturers' sales tax, rather than through a separate levy. The fund's revenue base is thus unrelated to its base for pension payments. Since Old Age Security Fund deficits are made up from general revenue, old age pension payments should clearly be treated as charges on the general revenue and Old Age Security Fund revenues as supplements to the relevant federal taxes. The Old Age Security Fund, linking pension payments and revenues, should therefore be disregarded for our purposes. Accordingly, the old age pension is classified in the second category of transfers——the straightforward transfer payment having a rate structure, determined by the federal government, applied to a set of demographic variables that defines the eligible population to yield a volume of federal payments. This second category includes family and youth allowances, old age pensions, war veterans pensions, and war veterans allowances.

We decided that interest on the public debt should constitute our third category of transfers, because these payments are determined by an analytic structure significantly different from those of the other two transfer categories.

2-1-6-1 PUBLIC SERVICE PENSION RECEIPTS
2-2-3-5 PUBLIC SERVICE PENSIONS

The public service pension transfers were handled in an exceptionally rough manner that enabled us to develop crude but usable equations. The model presented provides considerable scope for increased complexity and precision. On the other hand, the behaviour of the (public service) Superannuation Account in the Consolidated Revenue Fund is relatively uninteresting and does not appear to justify the time input we devoted to the highly cyclical Unemployment Insurance Fund. Public service pensions

have not to our knowledge ever been identified as an automatic stabilizer, although they undoubtedly represent one channel through which an expanding (or contracting) government sector may influence the long-run performance of the economy.

The revenues of the Superannuation Account (PSPR, DB 2166) are derived from three sources. First, all eligible federal employees pay a proportion of their salaries (males 6 1/2 per cent, females 5 per cent) into the account. Second, the federal government as employer matches this amount. Third, the government as trustee for the account pays interest on the amount in the account at the rate of 1 per cent per quarter. As well, the government makes up any actuarial deficits arising from changes in public service pay schedules, and hence in the expected liabilities of the account.

The flow of payments into the Superannuation Account in current dollars is modelled quarterly from 1955 to 1965. Although the Public Service Superannuation Act took effect in 1954, fitting equations from 1954 to 1965 generated large residuals in 1954, which suggested that there had been a start-up lag in the revenue collections of the account. PSPR is clearly a function of federal wage and salary payments (FGW, DB 2169) with the proportion varying for male and female employees. It would undoubtedly be easy to get a statistical breakdown of the public service showing the ratio of males to females, but for this equation we require a division of total wage payments to males and to females. Thus if the split were

$$FGW = FGWM + FGWF \qquad (1)$$

where FGWM, FGWF are federal government wage payments to males and to females, respectively, the proper explanatory variables would be .065 FGWM and .05 FGWF. One would expect these variables to be highly collinear, however, and for estimation purposes a composite variable (.065 FGWM + .05 FGWF) would be appropriate. But such a composite variable would require generation of these series on a quarterly basis, and time considerations suggested instead the approximation FGWM = 2/3 FGW, assumed to hold for all quarters. This assumption probably does not introduce serious errors, though it should be investigated. It yields the independent variable .06 FGW, using equation (1) above and the known percentage levies.

Furthermore an anomaly observed in 2Q60 suggests that there is an error in the revenue series. Reported revenues are \$54 million in 1Q60, \$43 million in 2Q60 and \$56 million in 3Q60. Thus a dummy variable was included for 2Q60.

The resulting equation is:

1Q55-4Q65

$$\underset{(6.06)}{\text{PSPR} = 9.386} + \underset{(29.89)}{3.156}\ (.06\ \text{FGW}) - \underset{(5.14)}{9.933}\ \text{DUM} \qquad (2)$$

SEE = 1.91 $\qquad \bar{R}^2 = .956 \qquad$ D/W = 1.63

This equation is generally satisfactory, although the significant constant term is unfortunate. There are at least two possible sources of specification error: the choice of .06 as the weighted average of .05 and .065 may be wrong, as may be the assumption of a stable average. Moreover the government's contribution, made to preserve the actuarial soundness of the account, is related to the rate of wage change as well as to FGW. Thus the constant term probably represents some form of specification error. The high coefficient on .06 FGW suggests that the government's interest and actuarial payments are roughly equal to the employees' contributions, so that the government pays two-thirds of the account's total revenues at the margin. On the standard test statistics the equation is adequate although not impressive. The proportion of explained variance at .956 is good but not great for this type of equation, the Durbin/Watson statistic suggests but does not establish autocorrelation in the residuals and corresponding systematic misspecification; but the standard error of estimate is very low, and the equation will do. There is not much variance around a trend in the PSPR series in any case.

Pension payments from the account (PSPP, DB 2180) are made to each retired public servant on the basis of 2 per cent of his average salary during the six consecutive years when that salary was highest, multiplied by the number of years worked up to a maximum of thirty-five years. Thus a full pension is 70 per cent of the salary paid in the top six-year earning period.

A theoretically satisfying explanatory variable for this series would require the use of a distributed lag of past retirements, each weighted by some average wage at retirement, with the lag pattern depending on the mortality experience of retired public servants. But the data from which such a series could be constructed do not appear to be available. The annual report of the Superannuation Account[39] contains data on contributors and beneficiaries, and on initiation and termination of pensions, but these data are annual and sparse at best. Moreover the material reported is not always consistent from year to year. Thus, as a quick approximation, we tried regressing pension payments on total FGW, and on FGW multiplied by a time trend (equal to 1 in 1Q54) to allow for a changing relation between the wage bill and pensions. Changing the initial period made very little difference, so we fitted the equations from 1954 to yield:

1Q54-4Q65

$$PSPP = \underset{(11.98)}{-12.074} + \underset{(28.10)}{.1189}\ FGW \qquad (3)$$

SEE = 1.451 $\qquad \bar{R}^2 = .944 \qquad$ D/W = .69

1Q54-4Q65

$$PSPP = \underset{(30.44)}{7.099} + \underset{(44.67)}{.0013}\ (T)(FGW) \qquad (4)$$

SEE = .928 $\qquad \bar{R}^2 = .977 \qquad$ D/W = .90

Autocorrelation is a serious problem in both these equations, as we might expect from the nature of our specifications. Any change in the rate of growth of public service wage payments should certainly lead to shifts in the ratio of pensions to wage bill, since pension liabilities are a function not of the current wage bill but of a distributed lag of past levels. Indeed, a strong argument could be made for testing distributed lags in

[39] *Report on the Administration of the Public Service Superannuation Act* issued annually by the Department of Finance.

this framework, though the caveat must be added that most estimation methods involving lagged endogenous variables would come to grief on the strong autocorrelation in the pension series. As for the test statistics, the trended equation (4) is clearly superior to equation (3). Autocorrelation is less severe, presumably because we have allowed the proportion of pensions to wage bill to vary. Efforts were also made to capture this variation with a linear time trend, but they were not successful. The linear terms were insignificant. For equation (4) the fit is good and the standard error small. The coefficients are strongly significant so that one may place some confidence in them in spite of the underestimate in their standard errors, which results from residual autocorrelation. It is not clear why pensions should be rising as a proportion of wages and salaries when the public service has been increasing so rapidly. Perhaps the greatest rate of increase in wages and salaries took place during World War II and immediately after——current increases being large in absolute magnitudes but proportionately smaller than in that period. This behaviour would produce the observed effect if the relative rate of growth were falling from 1954 on. We expect we could do better with the trended equation, particularly by introducing distributed lags; but for the time being it will serve the purposes of the model adequately. Changes in the Superannuation Account are never likely to be so dramatic that our dynamic misspecification will do serious harm to the actual behaviour of that account.

To attempt a disaggregated analysis of the heterogeneous mix of pensions included in PSPP does not seem to be a particularly profitable exercise. Most of the odd pensions (to pilots, Members of Parliament, and others) are in amounts too small to justify separate treatment, and since our analytic scheme is rough in any case these items may as well be lumped in with the main public service pensions.

2-1-6-2 UNEMPLOYMENT INSURANCE RECEIPTS
2-2-3-3 UNEMPLOYMENT INSURANCE BENEFITS

Total enrolment under the Unemployment Insurance Act depends on the size of the labour force involved and the level of income per capita, since coverage is restricted to workers with annual salaries below a certain ceiling. Annual salary per earner and

income per capita are of course not equivalent, and given the many highly variable non-salary components of income it is quite conceivable that the coverage level of the fund would be more closely related to a time trend than to movements in per capita income. The fundamental equation of the Unemployment Insurance Fund model determines the number of workers insured by the fund. Enrolment data used in this model were generated on a quarterly basis by averaging the monthly data in the D.B.S. reports on the operations of the fund.[40]

The proportion of labour force covered is subject to seasonal, cyclical and secular movements in labour force composition. Seasonally, one would expect to find that in the summer the labour force is augmented by agricultural workers, students, and other part-time workers who are not generally insured. The proportion of labour force covered should fall accordingly in the second quarter and more significantly in the third quarter. This pattern was modified by the extension of insurance to agricultural and horticultural workers as of April 1, 1967, but effects of the change in coverage will be hard to determine until more observations are available.

Cyclically, one would expect unemployment to cause casual workers and those in lower income brackets to drop out of the labour force (the 'discouraged worker' effect). This may lessen proportionate coverage because the remaining labour force is more heavily weighted toward workers above the salary ceiling. On the other hand, if such 'drop-out' workers are long-term unemployed whose insurance coverage has expired, they may reduce the uninsured labour force. Moreover, unemployment for the primary earner may also lead to the entry into the work force of other members of a family (the 'additional worker' effect). Such a secondary earner is generally employed at a lower salary level than that of the primary earner and is likely to be insurable, thus raising proportionate insurance coverage. Fluctuations in coverage are therefore subject to a number of factors pulling in different directions and one can hardly say a priori what the net effect will be. In fact there may be little net effect, but this issue may be resolved by statistical investigation.

[40] *Statistical Report on the Operation of the Unemployment Insurance Act* issued monthly by D.B.S., catalogue no. 73-001.

Finally, long-term shifts in the labour force between covered and uncovered occupations will produce corresponding shifts in the proportion of labour force covered. Thus expansion of the health and education industries, in which employees are largely uninsured, lowers the proportion covered, while reduction of the armed forces raises it.

After some experimentation, we found a definite trend in proportionate insurance coverage, but we picked up this trend best with a time-trend variable rather than with per capita income variables, as suggested in the first paragraph. We modelled seasonal shifts by using linear dummies; this produced better results than those obtained by using dummies proportionate to the labour force. Finally we tested an unemployment variable as a cyclical indicator. This variable had a significantly positive sign in early formulations but lost significance and thus was dropped from the final formulation.

The fundamental equation is:

1Q52-4Q65

$$
\begin{aligned}
INS = & -\underset{(.48)}{.4422}\ Q1 - \underset{(.80)}{.7563}\ Q2 - \underset{(.96)}{.9460}\ Q3 \\
& - \underset{(.79)}{.7588}\ Q4 + \underset{(3.70)}{.9695}\ NEP\ (D5) + \underset{(4.90)}{1.0020}\ NEP\ (D6) \qquad (1) \\
& + \underset{(1.21)}{.00218}\ T1\ (NEP)(D5) - \underset{(2.08)}{.00346}\ T2\ (NEP)(D6)
\end{aligned}
$$

SEE = .098 $\qquad \bar{R}^2 = .956 \qquad$ D/W = 1.12

This equation determines the average quarterly level of enrolment in the fund (INS, RDX 11257) as a function of quarterly seasonal dummies, the total number of paid workers (NEP, RDX 11064) and time trends. D5 is a quarterly dummy equal to 1 from 1Q52 to 3Q59 and zero thereafter. D6 is similarly defined as 1 in 4Q59 and all following quarters, and as zero in all quarters prior to 4Q59. The reason for this split is that on September 27, 1959 the annual ceiling was changed from a wage and salary ceiling of

$4,800 to a ceiling of $5,460 thus extending coverage to a larger proportion of the labour force. T1 and T2 are time trends: T1 is 6 in 1Q52 and increases to 36 in 3Q59 while T2 is 1 in 4Q59 increasing to 25 in 4Q65.[41]

Equation (1) fulfils some expectations, yet has puzzling features. There appears to be much variation in the seasonal pattern. Although the coefficients on the quarterly dummies match our a priori expectations, the t-test values indicate very high standard errors. The expected downward trend in coverage is clearly a feature of the post-1959 period, as shown by the negative coefficient on T2 (NEP)(D6). This negative coefficient implies that the rate of coverage of additions to the paid labour force has fallen from 100.2 per cent in 4Q59 to 91.5 per cent in 4Q65. Even more puzzling is the positive coefficient on the earlier term T1 (NEP)(D5). A positive coefficient implies a rise in marginal coverage rates throughout the 1950's (could this coefficient reflect shifts out of the uncovered agricultural labour force?) until coverage was 104.8 per cent in 3Q59 indicating a drop in the percentage covered in 4Q59——a most implausible result. Still, much depends on the size of the coefficient of T1 (NEP)(D5), which is only about 1.2 times its own standard error. The low Durbin/Watson statistic implies that the calculated standard errors are underestimates due to autocorrelation of residuals. Thus we may well suggest that the coefficient of T1 (NEP)(D5) is too large due to statistical error. As for general fit, equation (1) is easily the best located, with an $\overline{R}^2$ of .956. The autocorrelation problem, though obviously present, is much less severe than in other tests. We tried to develop a logarithmic format in order to remove some of the autocorrelation, but these efforts led to worse overall fits and low Durbin/Watson statistics.

Given an explanatory equation for the total enrolment of the fund, the next problem is to break down that enrolment into employed persons paying into the fund and unemployed persons receiving benefits. Data on both insured employed and claimants are also available from the monthly report on the operations of the Unemployment Insurance Fund. Since insured population is the sum

[41] T1 starts at 6 because the original estimation period for the equation began in 4Q50. When the equation was reestimated for inclusion in RDX1 the estimation period was changed to correspond more closely with the rest of the model.

of employed contributors plus claimants, and since our first equation determines the total insured, it is sufficient to develop an equation explaining either employed contributors or claimants. The other category follows by subtraction. We chose to focus on the number of claimants (CL, RDX 11247), which clearly depends on the total number of insured, the total unemployed (NU, RDX 11063), and seasonal factors. The fitted equation for claimants on the fund is:

1Q52-4Q65

$$\begin{aligned} CL = &-.2784 - .00328\ T + .1064\ INS + 1.2181\ Q1\ (NU) \\ &\quad (2.55) \quad\ (3.30) \qquad\quad (3.00) \qquad\quad (22.42) \\ &+ 1.0621\ Q2\ (NU) + .7248\ Q3\ (NU) + 1.0201\ Q4\ (NU) \\ &\quad (13.78) \qquad\qquad\quad (6.76) \qquad\qquad\quad (11.71) \end{aligned} \tag{2}$$

SEE = .0416 $\qquad$ $\overline{R}^2 = .953$ $\qquad$ D/W = 1.92

NU enters proportionately to the seasonal dummies Q1 to Q4. T is a trend term equal to 1 in 1Q52 and 56 in 4Q65. Why there should be a downward drift over time in claimants for a given level of insured population and unemployed is not clear. Still, this term is undoubtedly useful. If it is suppressed, the fit of the equation is weakened by all tests and the coefficient on INS becomes insignificant and negative. Seasonal constants proportional to the total unemployed produced better results than either linear dummies or dummies proportional to INS. The low coefficient in the third quarter and the peak in the first quarter suggest that a substantially higher proportion of winter than of summer unemployed are unemployment insurance fund claimants. Statistics for the winter quarters probably pick up the group entitled to seasonal benefits; the unemployed in the summer may include a higher proportion of 'hard-core' unemployed who have exhausted their benefits or who have never built up benefit rights. It is puzzling to find that the coefficients on unemployment are above 1 in three of the four quarters, although the average over four quarters is not significantly different from 1.

Given the determining equations for INS and CL, we can derive a series for employed contributors (EMPS, RDX 11246) by subtraction,

$$EMPS = INS - CL \qquad (3)$$

EMPS then becomes the basic explanatory series for the federal revenue components, employer and employee payments into the Unemployment Insurance Fund (UIR, RDX 2178). Similarly the determining equation for the unemployment insurance benefits paid out by the fund (UIB, RDX 2167) makes use of the series CL indicating the number of claimants on the fund.

Total benefits are determined by the number of claimants and the rate at which each claimant is paid. The rate of payment is determined by the claimant's income, up to a maximum level, and by whether or not the claimant has dependents. Because a consistently high proportion of claimants receive payment at the maximum rate, this rate was chosen to represent the whole structure. Moreover, since the proportion of claimants with dependents to single claimants appears to be quite stable at 53:47, the composite rate of benefit payment was derived by adding .53 times the maximum weekly rate for persons with dependents to .47 times the maximum weekly rate for persons with no dependents. The changes over time in maximum weekly benefit rates are shown in Table 10. Rate changes took place so close to quarter ends that in no case was it necessary to adjust the weighted benefit rate for a quarter to allow for rate changes within that quarter.

This calculated weighted rate variable (WR, RDX 11248) is the policy variable that, when multiplied by the quarterly average of the number of claimants, yields the average weekly payment in millions of dollars for a given quarter. Since there are thirteen weeks in a quarter and since the dependent variable is in millions of dollars the expected coefficient on WR (CL) should be about 13. Moreover the extension of the scope of the fund in 4Q59 creates a seasonal pattern in benefit payments not apparent before that year. This pattern is modelled by introducing short quarterly dummies (SQ1 to SQ4) running only from 1959 to 1965 and multiplicative with the WR (CL) variable.[42] Thus the benefit equation is:

[42]This is the version of the Unemployment Insurance Fund submodel that appears in RDX1. The fits of equations (4) and (5) are significantly improved by starting the seasonal pattern in 1Q59 rather than in 4Q59 when the shift in the structure actually occurred. Data revisions have been such that in later submodels of the fund, including the submodel designed for RDX2, the seasonal pattern does in fact start in 4Q59. Our preliminary results using the new data indicate that the seasonal pattern from 4Q59 does not differ markedly from the seasonal pattern shown in equations (4) and (5).

Table 10

MAXIMUM BENEFIT RATES UNDER THE UNEMPLOYMENT INSURANCE ACT
(Dollars per week)

Effective Date	Person without Dependents	Person with Dependents
July 1/41	12.24	14.40
Oct. 1/46	12.30	14.40
Oct. 4/48	14.40	18.30
July 1/50	16.20	21.00
July 14/52	17.10	24.00
Oct. 2/55	23.00	30.00
Sept. 27/59	27.00	36.00
June 30/68	42.00	53.00

Source: *The National Finances*, Canadian Tax Foundation, various issues.

1Q52-4Q65

$$UIB = \underset{(.49)}{-1.6573} + \underset{(22.04)}{8.7352}\ WR\ (CL) - \underset{(1.78)}{.5816}\ SQ1\ (WR)(CL)$$

$$+ \underset{(2.32)}{.8562}\ SQ2\ (WR)(CL) - \underset{(2.68)}{1.6359}\ SQ3\ (WR)(CL) - \underset{(9.72)}{3.5823}\ SQ4\ (WR)(CL) \qquad (4)$$

SEE = 9.80 $\qquad \bar{R}^2 = .966 \qquad$ D/W = 1.62

Results from this equation are somewhat curious. The constant term is insignificant as desired and the fit is good. On the other hand the quarterly coefficients are not strongly significant, and, in view of the possibility of autocorrelation, their true t-values may be even smaller than those shown. The coefficient on WR (CL) is smaller than one would like, particularly after 1959. One would expect it to be below 13, since obviously the 'average' claimant must receive less than the maximum payment. But it is surprising that he should receive 67 per cent of the maximum before 1959 and even less thereafter. This implies that unemployed claimants are drawn from lower income strata in times of prosperity (i.e. after 1959), though the extent of the overstatement of UIB by WR (CL) is hard to justify on these grounds.

The seasonal pattern suggests that claimants come from relatively high income groups in the second quarter, and from the lowest income groups in the fourth quarter. Does this mean that the seasonally unemployed tend to have relatively low weekly earnings? It is possible, but rationalization on the basis of these coefficients is a pretty shaky business. Basically we simply do not know very much about the composition of the unemployed either on a seasonal basis or over time. If and when we can develop more detailed labour-market equations in the model, we may be able to make less speculative statements about the structure underlying our unemployment insurance subsector.

In the equation explaining UIR, there is no satisfactory way of introducing the rate structure as a policy variable. Payments are made by workers in covered industries receiving less than a set amount per year in wage and salary income; within that class

equal weekly payments are made by employer and employee of an amount that depends on the weekly earnings rate of the employee. After the 1959 amendments to the Unemployment Insurance Act, this amount varied from a low of 10 cents per week each when an employee earned less than \$9 weekly to a high of 94 cents each when weekly earnings were \$69 or more; prior to these amendments the range extended from 8 cents to 60 cents per week. In addition, the government pays one-fifth of the total employer and employee contribution. A model of the rate structure would thus require disaggregation of the contributing population by earning class. Alternately, we could assume that the maximum rate is representative of the rate structure, as we assumed in the case of the benefit equation. This would lead, after 1959, to a weekly payment of \$2.256 or a quarterly payment of \$29.33 per employed insured worker. If this constant value were multiplied by the total employed population, an exogenous variable for the revenue equation would result.

In fitting the UIR equation a simpler procedure was used, which consisted of regressing UIR on the series for employed contributors, EMPS, from 1952 to 1965. In addition a second series, EMPS (D6), was set equal to zero from 1Q52 to 3Q59 and equal to EMPS thereafter, allowing for the shift in contributions that took place in 1959. A seasonal pattern was also introduced from 1Q59 to 4Q65 to capture the change in seasonality introduced by the 1959 amendments. The resulting revenue equation is:

1Q52-4Q65

$$\begin{aligned} UIR = {} & \underset{(2.82)}{7.9902} + \underset{(12.31)}{10.7738}\ EMPS + \underset{(20.80)}{6.4002}\ EMPS\ (D6) + \underset{(3.83)}{1.3212}\ SQ1\ (EMPS) \\ & - \underset{(4.90)}{1.7033}\ SQ2\ (EMPS) - \underset{(.40)}{.1407}\ SQ3\ (EMPS) + \underset{(.15)}{.0585}\ SQ4\ (EMPS) \end{aligned} \tag{5}$$

SEE = 1.79 $\quad \bar{R}^2 = .987 \quad$ D/W = 2.04

This equation looks most impressive by all the standard tests. The only questionable feature is the obviously low significance of the third- and fourth-quarter seasonals. But if the seasonals are eliminated the standard errors on EMPS and EMPS (D6) are in-

creased, and both the proportion of explained variance and the Durbin/Watson statistic are significantly reduced. The last two seasonals are left in for symmetry. As for the coefficients on EMPS and EMPS (D6), the shift means that after 1959 the coefficient on total insured employed is 17.05. If all the employed contributed at the maximum rate, the coefficient should be about 29.33. Thus our equation suggests that the choice of full-rate contribution, as representative of the whole structure, would be less appropriate here than in the benefit equation. This is probably the case because the range of contribution rates for different weekly-earning classes is much greater than the range of benefit rates. The highest benefit rate was 4.5 times the lowest in 1965, while the highest contribution rate was 9.4 times the lowest. But our inability to model the rate structure satisfactorily does not preclude analysis of changes. The roughly 50 per cent rise in contribution rates in 4Q59 is clearly reflected in the coefficient on EMPS (D6). Thus the total coefficient increases from 10.77 to 17.05. Any future increase in the rate structure, if proportionate across the whole structure, could be modelled by an additional EMPS (D7) variable with an appropriate coefficient.

The entire unemployment insurance model therefore consists of four stochastic equations and an identity, explaining one federal revenue series and one transfer series. Included are two policy levers——one explicit in the benefit equation (WR) and one implicit in the total coefficient on EMPS in the revenue equation. Both these equations require certain assumptions about the rate structure: first, that all contribution or benefit rates at different income levels are adjusted equiproportionately when changes are made, and second, that the distribution of contributors and beneficiaries among income classes is unchanged over time. These assumptions cannot be avoided unless a separate analysis is performed for each weekly-earning class, which would require twelve models instead of one as well as analysis of income-class interactions. The aggregation used here seems clearly preferable. Moreover the fit of the whole model is very good. If any area were to be improved, further work should be done on the INS explanatory equation, which is fundamental to the whole system.

2-2-3-1 FAMILY AND YOUTH ALLOWANCES

These payments constitute one of the most straightforward of the transfer programs from a modelling point of view. Eligible recipients are exogenous to the model but very closely related to total population in the relevant age groups. The rate structure is a pure policy variable, and the product of the two is the obvious explanatory variable for the equation.

The family allowance program, initiated on July 1, 1945, provides a monthly payment to the mother or guardian on behalf of every child under 16 fulfilling certain residence requirements. Allowances are currently \$6 per month for each child younger than 10 years of age and \$8 per month for each child 10 to 15 years old. Prior to September 1, 1957, monthly rates were \$5 for each child under 6, \$6 from 6 to 9, \$7 from 10 to 12, and \$8 from 13 to 15. This rate structure is the main policy variable controlled by the federal government. Although it can change the eligibility requirements, very little scope exists for broader eligibility within the present age range, other than through extending the allowance to dependents of Canadians serving abroad.

Payments under the youth allowance program were instituted in September 1964. They are made at the rate of \$10 per month on behalf of all children 16 or 17 years of age attending school or university full time. Quebec opted out of this program in return for an additional income tax abatement of 3 percentage points.

The Dominion Bureau of Statistics provides annual data as of June 1 on the number of persons in the age categories 0-4, 5-9, 10-14, and up by five-year ranges to 90 and over. Quarterly series derived from these annual series by linear interpolation are stored on tape as DB 3033 (population aged 0-4) to DB 3051 (population aged 90 and older) and DB 3032 (total population). From these data, base series for the family allowance were derived by proportional allocation. Thus the population 0-4 added to one-fifth of the population 5-9 was assumed to equal population 0-5 for any given quarter. The remaining four-fifths of the 5-9 cohort is the population 6-9. Similarly, three-fifths of the 10-14 category is 10-12 and the population 13-15 is determined as two-fifths of the 10-14 category plus one-fifth of the 15-19 category. The four series thus created are denoted $KIDS_i$ where i goes from 1 to 4

to denote the population classes 0-5, 6-9, 10-12, and 13-15, respectively. Such a procedure is of course unreliable if sharp fluctuations occur in birth rates, since this would lead to changing proportions of a given five-year cohort being accounted for by any one year. We thought, however, that errors of this kind would not be very serious given the relatively regular behaviour of the Canadian postwar birth rate. The sharp drop in birth rates in the early and middle 1960's may require that more precise numbers be obtained.

The population series required for modelling the youth allowance component of total payments was not so readily attainable. We need the subset of the population 16-17 residing outside Quebec and attending school or university full time. The annual reports of the Department of National Health and Welfare list the number of students receiving youth allowances as of March 31st. As a first approximation we assumed that this number was applicable in each quarter of the appropriate school year, denoting the series so created as STUD. This assumption ignores the seasonal variation attributable to dropouts and seasonal irregularities in births, but since youth allowances affect only six quarters in our data set we decided the approximation would serve. As the model is run forward alternative schemes for forecasting the population receiving youth allowances should be investigated.

The family allowance variable is the product of the quarterly family allowance rate (FAR) and the population in the relevant age group (KIDS). There are four FAR variables, corresponding to the four KIDS variables. FAR_1, which is applied to the 0-5 cohort, is equal to \$15 prior to 3Q57 and \$18 after 3Q57. In 3Q57 FAR_1 is equal to \$16 to allow for the change in monthly rates on September 1. Similarly FAR_3, which applies to the 10-12 cohort, equals \$21 before 3Q57, \$22 in 3Q57 and \$24 in following quarters. Throughout our estimation period, FAR_2 and FAR_4 are equal to \$18 and \$24, respectively. The youth allowance variable is the product of the quarterly youth allowance rate (YAR) and the number of students to whom allowances are payable. YAR had a value of \$10 in 3Q64, since payments were initiated in September of that year, and \$30 thereafter. Prior to 3Q64 YAR equalled zero. We attempted to regress family and youth allowance payments (FAYP, DB 2173) on all the compound variables at once, but it was found that collinearity among the variables made this procedure value-

less. Consequently the rate-times-base variables were summed across age groups to yield a single compound variable on which to regress FAYP.

The resulting equation involves several possible sources of error. The population data used are only estimates of the actual quarterly population, while these in turn should be reduced by an unknown amount in order to make estimates of the recipient population. At any given time some small part of the Canadian population may be ineligible for such payments or may simply not apply for allowances.

The fitted equation for the compound variable alone is:

1Q52-4Q65

$$FAYP = \underset{(1277.1)}{.992325} \left[\sum_{i=1}^{4} (FAR_i)(KIDS_i) + (YAR)(STUD) \right] \quad (1)$$

SEE = .684 $\bar{R}^2$ = .999 D/W = .802

The coefficient is close to unity, as it should be since the population variables are in millions and the rates are quarterly, but its standard error indicates that the coefficient is significantly below 1. Before we conclude that some diehard free enterprise group continues to reject government charity, however, it should be noted that the severe autocorrelation of residuals suggests that the standard error is underestimated.

Further experimentation seemed in order, both to reduce the autocorrelation and to check the test statistics. The constant term was readmitted, and in addition equations were fitted with trend and reciprocal-trend variables running from 1Q52 to 4Q65. The reciprocal trend was no help at all, but the other two specifications gave:

1Q52-4Q65

$$\underset{(539.8)}{FAYP = .98219} \left[\sum_{i=1}^{4} (FAR_i)(KIDS_i) + (YAR)(STUD) \right] + \underset{(5.92)}{.03864}\ T \qquad (2)$$

SEE = .538 $\qquad \bar{R}^2$ = .9994 $\qquad$ D/W = 1.31

$$\underset{(283.29)}{FAYP = 1.01168} \left[\sum_{i=1}^{4} (FAR_i)(KIDS_i) + (YAR)(STUD) \right] - \underset{(5.51)}{2.313} \qquad (3)$$

SEE = .552 $\qquad \bar{R}^2$ = .9993 $\qquad$ D/W = 1.29

Equation (2) seems to be the better of these two equations. Both are superior to the equation with a compound variable alone, and the trended equation seems to suffer somewhat less from autocorrelation. But equations (2) and (3) tell the same story——the coefficient on the compound variable differs significantly from unity and the total payments rise over time as a proportion of the compound variable. Perhaps a small group has been left out of the program, a group shrinking relatively over time. In any case the observed fit makes it clear that extra refinement to isolate this phenomenon will not repay the effort.

2-2-3-2 VETERANS PENSIONS AND ALLOWANCES

The behaviour of war veterans pensions may be modelled by simply applying the rate structure prevailing in any quarter to the existing eligible population. But a complication arises because the eligible population is defined in a rather restrictive manner and cannot be projected into the future by using a subset of existing demographic forecasts. One cannot assume the behaviour of war veterans and their dependents to be similar to that of the whole population. For a complete model of this sector one must try to predict total transfers, given rate and base, as well as the base itself for future years. The rate structure, of course, remains as a policy variable. Although the scope for expansion of eligibility creates a further lever by which the

government may act on these transfers, we have not been able to build this factor into the equation.

The basic data series to be explained are pensions to veterans of World War I and World War II and their dependents (WWP, DB 2176), and War Veterans Allowances (WVA, DB 2177). Pensions are payable to disabled veterans and to dependents of veterans whose deaths were attributable to military service. Civilians disabled while serving with the forces are also eligible. Although pensioners need not reside in Canada, pensions paid to non-residents are treated as goods and services expenditure, not as transfers. These pensions are payable by degree of disability up to a maximum level for total disability. In addition, War Veterans Allowances are payable to aged or disabled veterans who are unable to provide for their own maintenance. Such allowances are also payable up to a maximum and in fact most allowances are paid at the maximum rate. In 1965 these two categories accounted for payments of \$171 million and \$108 million respectively——virtually all of the war-related transfers to persons.

The rate structure for disability and death pensions is complicated by the fact that, as originally set up, the pension rate depended on the rank of the veteran. But successive increases over time have raised only the floor pension, leaving the pension for upper ranks static. By January 1, 1968, this process had equalized pensions for all ranks at \$3,180 for total disability and \$2,400 for dependents of deceased veterans. The accompanying table shows the shifts over time in the floor pension rate per annum. These figures, divided by four to reach a quarterly basis and appropriately adjusted for within-quarter changes, yield the quarterly pension rates for disabled war veterans (WVR) and for dependents of deceased veterans (DR). The quarterly figures for disabled veterans on pension (VETS) and for dependents of veterans whose death resulted from military service (DEPS) are derived by linear interpolation of annual data provided in the annual reports of the Department of Veterans Affairs.[43]

With these series we can fit an equation for total war pension payments:

[43]Department of Veterans Affairs, *Annual Report, 1965-1966*, Tables XXVII and XXVIII, pp. 69-70.

Table 11

BASIC ANNUAL RATES OF PENSION BENEFITS
(Dollars)

	Basic Rate of Benefit for: Total Disability	Death	Ranks Payable
1925 to 3Q47	900	720	Lieutenant and below
2Q48 to 4Q51 (retroactive to 4Q47)	1,128	900	Major and below
1Q52 to 2Q57	1,500	1,200	Major and below
3Q57 to Feb. 28/61	1,800	1,380	Lieutenant-Colonel and below
Mar. 1/61 to Aug. 31/64	2,160	1,656	Colonel and below
Sept. 1/64 to Aug. 31/66	2,400	1,824	Colonel and below
Sept. 1/66 to Dec. 31/67	2,760	2,100	*
Jan. 1/68 to present	3,180	2,400	All ranks

* The $2,760 disability rate is applicable to all ranks; the death benefit of $2,100 applies only to ranks of Colonel and below.

Source: *The National Finances*, Canadian Tax Foundation, various issues.

1Q52-4Q65

$$WWP = -5.0838 + .24768\ (WVR)(VETS) \quad (1)$$
$$\qquad\qquad (3.77) \qquad (1.81)$$
$$+ 1.9579\ (DR)(DEPS) + 2.0852\ DUM1$$
$$(2.10) \qquad\qquad (3.17)$$

SEE = .641 $\bar{R}^2$ = .985 D/W = 1.61

DUM1 is a dummy with a value of 1 in 2Q61 and zero elsewhere. On March 1, 1961 pension rates were increased for both disability and death payments. One would therefore expect an increase in the WWP series in 1Q61 and a larger increase in 2Q61. The national accounts figures for WWP are \$34 million in each quarter of 1960 and in 1Q61, \$43 million in 2Q61 and \$40 million in 3Q61, suggesting that increases made in March 1961 were not entered in the *National Accounts* until the second quarter of that year. To take account of this apparent recording lag we have ignored the within-quarter rate increase in calculating WVR and DR for 1Q61 and added DUM1 to pick up the additional payments, over and above those due to the rate increase, in 2Q61. Our rate variables are in dollars per quarter, the population variables in millions, and WWP is in millions of dollars per quarter. The coefficients on WVR (VETS) and DR (DEPS) should thus reflect the extent to which the rate we assumed to be representative truly reflects the rate structure. The coefficient on DR (DEPS) suggests that our DR series is only about one-half the true weighted rate while that for WVR (VETS) indicates that the average VET is only 25 per cent disabled. High standard errors associated with these terms, however, indicate the presence of severe multicollinearity, and we require more reliable estimates of the impact of changes in WVR and DR on WWP, particularly for use in simulation experiments.

We therefore proceeded by combining our two main independent variables in the form of a weighted sum. The weights were determined by taking fiscal year totals for WVR (VETS) and DR (DEPS) and comparing them with the actual annual liability at fiscal year-end for disability and dependent pensions, respectively. Actual data used for comparison are given in the annual reports of the Department of Veterans Affairs. The ratio 'actual disabil-

ity pension liabilities/WVR (VETS)' was calculated from the fiscal year ending March 31, 1948 to the fiscal year ending March 31, 1965. A trend in this ratio would indicate that the representativeness of our WVR rate was changing over time. Evidence of such a trend was very slight,[44] and we used the average of the ratio (.3844) to weight the WVR (VETS) term. A similar ratio computed for DR (DEPS) revealed even less evidence of a trend. Again we used the average (.8704) to weight the DR (DEPS) term.

The fitted equation obtained is shown below.

1Q52-4Q65

$$\begin{aligned} WWP = \underset{(5.63)}{-3.7651} + \underset{(57.55)}{1.0443}\,[.3844\,(WVR)(VETS) \\ + .8704\,(DR)(DEPS)] + \underset{(3.25)}{2.1361}\,DUM1 \end{aligned} \qquad (2)$$

SEE = .642 $\bar{R}^2$ = .984 D/W = 1.56

These test statistics are quite satisfactory and almost identical with those for equation (1), as they should be. Implicit coefficients on WVR (VETS) and DR (DEPS) are now quite different from those previously obtained, being .4014 and .9090 respectively. The coefficient on the compound term is significantly larger than the value of unity one would expect. This may be due to the use of only World War I and World War II data to compute our independent variables. A small percentage of pension payments in WWP arises from other wars and special circumstances, and to this extent our independent variable understates the actual liabilities under the pension legislation.

War Veterans Allowances (WVA, DB 2177) were instituted in 1930. From September 1, 1964 to August 31, 1966 the rate of payment was

[44]The first observation was .3756 and the last was .3974. Eleven of the first differences were positive and six were negative.

$94 per month or $282 per quarter to a single individual unable to provide for his own support.[45] Higher rates were payable for married couples or orphaned families, but the single rate was chosen as representative of the rate structure as a whole. In addition, no effort was made in the equation structure to allow for the impact of the income ceiling. The permissible income ceiling for a single person from September 1, 1964 to August 31, 1966 was $133 a month and for married couples $222. These ceilings were raised to $145 and $245 a month, respectively, on September 1, 1966. The quarterly series of recipients (RVA) and quarterly rates (VAR) adjusted for quarters of change are taken from the annual reports of the Department of Veterans Affairs as are the base series for the pension equation. Our estimated equation is:

1Q52-4Q65

$$\underset{(5.34)}{\text{WVA} = 1.0402} + \underset{(81.04)}{1.0536}\ (\text{VAR})(\text{RVA}) + \underset{(4.73)}{2.8157}\ \text{DUM2} \qquad (3)$$

SEE = .581 $\qquad \overline{R}^2$ = .992 $\qquad$ D/W = 2.02

DUM2 takes the value 1 in 3Q52, and is zero elsewhere to allow for a retroactive rate increase in that quarter. The equation fits at the 99 per cent level and there is no evidence of autocorrelation. The coefficient on the base variable is, however, significantly greater than 1. This understatement in our base variable is due to offsetting factors, with the presence of married recipients tending to push the coefficient above 1 and the effect of the income ceiling acting to depress the coefficient below 1.

The rate variables in these two equations are clearly government policy parameters requiring no further consideration. But the series VETS, DEPS, and RVA are exogenous to the model and must be projected in some manner if the model is to be run forward. Of the three, DEPS is the easiest to project. Although DEPS consists of two distinct cohorts, World War I (WWI) and World War II (WWII) dependents, graphing the two separately yielded no addi-

[45]On November 30, 1966 the single rate was increased, retroactive to September 1, 1966, to $105 a month and the married rate to $175 (from $161).

tional information. After 1955, the total DEPS series follows a simple autoregressive scheme of the form:

1Q55-4Q65

$$DEPS = \underset{(5991.11)}{.99755}\ DEPS_{t-1} \qquad (4)$$

SEE = .0000356 $\qquad \overline{R}^2 = .9989 \qquad$ D/W = .160

or, alternatively

$$DEPS = \underset{(9.85)}{-.000909} + \underset{(357.94)}{1.02575}\ DEPS_{t-1} \qquad (4')$$

SEE = .0000198 $\qquad \overline{R}^2 = .9997 \qquad$ D/W = .523

Either equation seems satisfactory, although the latter is probably preferable because of its better fit. Before 1955 the DEPS series follows no regular pattern. What is extremely surprising is the very slow rate of decline of DEPS, a feature not only of the years after 1955 but of the whole period. The total dependents' pensions resulting from World War I reached a maximum of 20,015 in fiscal 1925, yet had only declined to 14,027 by 1966, forty-one years later. Total dependents' pensions resulting from both world wars peaked at 34,403 in 1950 and were 29,913 in 1966. If the decline is linear, pensions will reach zero in about 2077, while if the post-1955, autoregressive pattern holds DEPS will be with us for generations. Consequently it is doubtful if this structure can be maintained into the middle-run future. Widows and orphans seem to be extraordinarily long-lived.

In the case of disabled veterans we obtain a clear gain in information from separating the World War I and World War II cohorts. There appears to be a definite postwar veteran cycle, which is seen after World War I and may be followed with roughly a twenty-year lag by the World War II cohort. The World War I group rises irregularly to a peak of 80,133 in 1940, then falls exponentially on a smooth curve down to the present. This group is thus easy to project into the future. The World War II group

seems to have reached a peak in 1964, and one may therefore assume that it will decline thereafter according to the same pattern as the World War I group. Thus we break down VETS by war into

$$\text{VETS} = \text{VETS I} + \text{VETS II}$$

Then we subtract VETS I in each post-1940 quarter from the maximum 1940 value to get a series

$$\text{DVETS I} = .080133 - \text{VETS I}$$

DVETS I is the divergence between current and peak numbers of disabled World War I veterans, and it increases exponentially from 1940 onward. Then if we fit a log relation the equation is:

1Q47-4Q65

$$\ln \text{DVETS I} = \underset{(172.17)}{-9.0008} + \underset{(100.39)}{1.26904} \ln T \qquad (5)$$

SEE = .040 $\overline{R}^2 = .993$ D/W = .026

where T is a trend equal to 1 in 2Q40, and 103 in 4Q65.

We have an excellent fit for the equation but the extreme autocorrelation shows that the exponential form is misspecified. As it stands, we have a model saying

$$\ln D = a + b \ln T$$

so $$D = AT^b$$

where $$A = e^a$$

Given this form, D = .080133, or VETSI = 0, when ln T = 5.1036 or when T = 165. This will occur in approximately the middle of 1981, and our equation thus implies that veterans disability pensions arising from World War I will be zero by then. The functional form implies

$$\frac{dD}{dT} = bAT^{b-1} = \frac{b}{T} D$$

and thus the rate of increase of D rises as T rises, because the observed b is greater than 1. An alternative form

$$\ln D = a + bT$$

was tried but yielded a weaker fit. This of course implies

$$D = Ae^{bT}$$

and

$$\frac{dD}{dT} = bAe^{bT} = bD$$

which indicates a rate of rise of D increasing faster than the previous form, though this rate is initially slower due to smaller values of b. Neither form is fully satisfactory, but the former seems reasonably adequate for short-term prediction. We can then plug into this equation the value T = 1 in 1Q64, if that is the peak quarter, and derive successive values for DVETS II, which, when subtracted from the peak value .106628, will yield a series VETS II. The two series can then be summed to yield projections of VETS.

But for the recipients of War Veterans Allowances (RVA) no projection scheme seems adequate. The series rises steadily at least until 1966 with no sign of a peak. On March 31, 1966 the number of recipients stood at 85,835. This upward trend is a combination of aging veteran population and expanding eligibility, but surely a peak must come soon. We have no way of knowing when the downturn will occur or what form it will take. RVA may begin to drop sharply in the near future, or may just keep rising. One can project RVA at its latest level until a down-trend is asserted; alternately one could apply an autoregressive scheme such as that used for DEPS. But both efforts would be based on guesswork.

2-2-3-6 OLD AGE PENSIONS

The old age pension was initiated on January 1, 1952. Monthly payments at the rate of $40 were made to any Canadian over 70 years of age who met certain residence requirements previous to application. In 1960 coverage was extended to non-residents with twenty-five years of residence in Canada after age 21. The pension was increased to $46 per month on July 1, 1957, and to $55 on November 1, 1957. On February 1, 1962 the pension was again increased to $65, and on October 1, 1963 to $75. In April 1965 provision was made for a cost-of-living adjustment to the pension (with a maximum increase of 2 per cent per year) based on the Canada Pension Plan Pension Index, effective in 1968, but this is outside our data period.[46] The April 1965 legislation provided as well for the payment of old age pensions in 1966 to persons born in 1897 and earlier. Coverage was extended progressively so that in 1970 and thereafter pensions become payable at age 65.

We combined monthly rates to form the quarterly series for the old age pension rate (OAPR). The base series, Canadians 70 years of age and over, is the sum of DB 3047 to DB 3051, and is designated AGED. These population series are derived by quarterly interpolation of annual demographic data supplied by the Dominion Bureau of Statistics. The dependent variable is old age pension payments (OAPP, DB 2182).

1Q52-4Q65

$$\text{OAPP} = \underset{(808.78)}{1.0019}\ (\text{OAPR})(\text{AGED}) \qquad (1)$$

SEE = 1.352 $\bar{R}^2$ = .9992 D/W = .574

[46]On January 1, 1967 a program of Guaranteed Income Supplements became effective. This program guarantees that old age security recipients will receive a minimum monthly income of $105 in 1967. In 1968, the GIS was also made subject to a cost-of-living adjustment with a maximum increase of 2 per cent per year.

or, alternatively

$$\text{OAPP} = \underset{(1105.79)}{1.0030}\ (\text{OAPR})(\text{AGED}) - \underset{(7.18)}{5.7488}\ (1/T) \qquad (2)$$

SEE = .976 $\qquad \bar{R}^2 = .9996 \qquad$ D/W = 1.038

T in equation (2) is a time trend from 1Q52 to 4Q53 allowing for an apparent initial registration lag. Without this time trend there were substantial negative residuals in the first few years. Because the independent variable is quarterly payments in millions of dollars, the basic coefficient is 1. The inverse trend term is clearly helpful in dealing with autocorrelation, although further examination of residuals suggests that the term might well have been extended to 4Q54. On balance this is a very simple and straightforward equation, and further tinkering would be unproductive.

2-2-4 INTEREST ON THE FEDERAL PUBLIC DEBT

Interest on the federal public debt (IFD, DB 2181) is the largest category of transfers to persons. It now runs at over a billion dollars each year. The amount of the transfer obviously depends on the total amount of debt outstanding and the average coupon rate on this debt. Within the block of federal debt it is useful to distinguish three classes of instruments usually sold in different markets and subject to different forms of rate behaviour. These are treasury bills (TB, DB 636), other direct market securities (DMS), and Canada Savings Bonds (CSB). Treasury bills are short-term, highly liquid assets with a rate structure assumed to be based on the key rate, the three-month treasury bill rate (RTB, DB 601), average of Thursdays. DMS comprises all the regularly traded federal debt with varying maturities and yields and semiannual coupons. DMS also includes a small block of perpetuals, sold at a $55 million face value and a 3 per cent coupon rate, carrying a constant annual interest charge of $1.65 million. The third category, CSB, consists of fixed-yield securities, redeemable on

demand at par plus accrued interest. The coupons are redeemable annually on November 1st.[47]

Prior to 1960 the patterns of coupon redemption described above created a seasonal pattern in the interest liabilities series, because all interest was reported on a paid basis in the *National Accounts*. Thus CSB interest payments were concentrated in the fourth quarter, while interest payments on direct market securities shifted about depending upon which pair of quarters had the highest proportion of semiannual payments. Starting in 1960 interest liabilities have been reported in the *National Accounts* on an accrual basis, which should have eliminated the seasonal pattern. However, this pattern has not been entirely eliminated. Consequently our final equation embodies two seasonal patterns: AQ1 to AQ4 running from 1Q55 to 4Q59, and BQ1 to BQ4 running from 1Q60 to 4Q65. The need for the second set of quarterly dummies suggests that some problems remain in recording interest liabilities on an accrual basis.

The independent variables needed to construct the equation were generated as described below. To arrive at the treasury bill interest liabilities variable, we multiplied the treasury bill rate (RTB) by the value of bills outstanding at the end of the quarter (TB). Since RTB is expressed in per cent per annum, the expected coefficient on the compound variable is .0025. In dealing with the other two classes of debt, a more complicated procedure was required due to the wide variety of rates on the debt outstanding at any one time. We attempted, with little success, to find a single rate or a simple moving average of rates that would serve as a representative for the whole structure. Instead we broke down the DMS variable into individual issues for each quarter in our data period,[48] and derived an interest liabilities series by multiplying the amount of each issue outstanding at the end of the quarter by the coupon rate for that issue. An issue outstanding for only part of a quarter was assumed to be outstanding for the whole quarter but to be reduced proportionately. Thus a $100 million issue retired

[47]Although coupons of the 1956 CSB issue were redeemable annually on May 1, we ignored this irregularity in calculating our interest liabilities series.

[48]See the table "Details of Unmatured Outstanding Issues" in *Bank of Canada Statistical Summary* issued monthly by the Bank of Canada.

at mid-quarter would be counted as $50 million for the whole quarter. Summing the resulting quarterly liabilities series across all issues gave us total quarterly interest liabilities for direct market securities (DMSL).

A similar procedure was followed to obtain a series for Canada Savings Bond interest liabilities (CSBL), although the calculations in this case were more complex. These instruments are issued in the fourth quarter of the year and dated November 1st. Sales of an issue are generally continued through the first three quarters of the following year and are then discontinued. The amount of CSB's outstanding, disaggregated by issue, is not readily available on a quarterly basis. However, estimates are available for the amount of each issue outstanding as of January 1st of each year.[49] They are taken as the stock outstanding of each CSB issue at the end of the fourth quarter of the previous year. For all issues except the current one the change from fourth quarter to fourth quarter is a measure of redemptions. For the current issue, however, the change in the calendar year following the year of issue is a combination of both sales and redemptions. This net change has been negative for all issues, indicating that redemptions typically exceed sales (in most cases by relatively large amounts) in the year after a new CSB issue. The belief that gross sales of CSB's in the calendar year following issue are small, and probably insignificant compared with the total sales in the quarter of issue, led us to adopt the convenient assumption that these sales are not significantly different from zero. This implies that we treated the first year change in current CSB's outstanding as entirely due to redemptions, and, in effect, ignored minor CSB sales occurring in three quarters.

Given an annual series of redemptions for each CSB issue we had to decide how to spread these on a quarterly basis. We have no information on the quarterly pattern of redemptions, but it seems reasonable to expect that a large proportion of annual redemptions are due to 'roll-overs' when a new issue is sold. If so, annual redemptions would be heavily concentrated in the fourth quarter. We experimented with three spreading ratios: the first was a simple linear interpolation; the latter two involved a non-

[49]These estimates are published in *Loans of Government of Canada and Loans Guaranteed by the Government of Canada* issued annually by the Bank of Canada.

linear interpolation with quarterly weights of .2, .2, .2, .4, and .1, .1, .1, .7, respectively. Each of these three approximative procedures yielded a different series for quarterly CSB's outstanding by issue. These three series were used to generate three CSBL series. The relative performance of these alternative CSBL series in the estimated GINT equation, both within the estimation period and in the forecast period, was our criterion for selecting the 'most reasonable' method of interpolation. Both of the nonlinear procedures were superior to the simple linear interpolation (as one might expect), and the CSBL series based on the assumption that 70 per cent of the redemptions occurred in the fourth quarter proved to be the best of the three.

Using this quarterly series for CSB's outstanding, CSBL was calculated in the following way. We first generated two liabilities series, one on a paid basis (CSBLP) and one on an accrued basis (CSBLA). We then have

$$CSBL = D1\ (CSBLP) + D2\ (CSBLA) \qquad (1)$$

where D1 = 1 from 1Q55 to 4Q59 and zero thereafter, and D2 = 1 from 1Q60 forward. Interest on an accrued basis, CSBLA, was calculated as follows:

$$CSBLA = 1/4 \sum_{i=1}^{m} \left[\frac{X_{it-1} + X_{it}}{2}\right]\left[\frac{CR_{it-1} + CR_{it}}{2}\right] \qquad (2)$$

where X_{it} is the amount of the CSB of issue i outstanding at the end of quarter t, and CR_{it} is the annual coupon rate (expressed as a decimal) applicable to X_{it} in quarter t. The amount of a CSB issue outstanding fluctuates daily. Therefore quarterly CSB's outstanding for each issue were found by averaging the beginning- and end-of-quarter values. Such a procedure gave us an approximation of CSB's outstanding at mid-quarter.[50]

[50]The coupon rate on a CSB may be changed during the life of the issue. For this reason we averaged successive quarterly coupon rates to get the rate that most accurately reflects the mid-quarter rate. Changes that have occurred in the past have always taken place in the fourth quarter.

The CSBLP series is more complex. What we required for the first three quarters is the amount of redemptions by issue multiplied by the annual coupon rate for that issue (expressed as a decimal) and scaled by some fraction representing the actual proportion of the annual interest received at the time of redemption (remembering that the 'year' for purposes of interest payments runs from November 1 to October 31). For the fourth quarter, we needed a similar expression, but we also needed a measure of the interest paid on the stock of CSB's outstanding on November 1. We assumed that redemptions are spread evenly throughout the quarter, and that all monthly redemptions are made on the last day of the month. This gave us the expression:

$$\begin{aligned} CSBLP = \sum_{i=1}^{m} [&1/3\ Q1\ (\Delta X_{it})(CR_{it}) + 7/12\ Q2\ (\Delta X_{it})(CR_{it}) \\ &+ 10/12\ Q3\ (\Delta X_{it})(CR_{it}) + 1/12\ Q4\ (\Delta X_{it})(CR_{it}) \\ &+ Q4\ (X_{it-1})(CR_{it-1})] \end{aligned} \tag{3}$$

The CSBL and DMSL series calculated in the manner described above are reproduced in the data appendix.

The estimated IFD equation is shown below.

1Q55-4Q65

$$\begin{aligned} IFD = {} & \underset{(3.14)}{.00227}\ (TB)(RTB) + \underset{(6.91)}{1.50581}\ CSBL + \underset{(17.97)}{.28029}\ AQ1\ (DMSL) \\ & + \underset{(26.25)}{.42515}\ AQ2\ (DMSL) + \underset{(20.92)}{.35666}\ AQ3\ (DMSL) + \underset{(2.29)}{.11272}\ AQ4\ (DMSL) \\ & + \underset{(10.55)}{.27656}\ BQ1\ (DMSL) + \underset{(12.78)}{.32316}\ BQ2\ (DMSL) + \underset{(12.71)}{.31890}\ BQ3\ (DMSL) \\ & + \underset{(11.88)}{.29831}\ BQ4\ (DMSL) \end{aligned} \tag{4}$$

SEE = 8.373 $\bar{R}^2$ = .975 D/W = 2.15

On the whole this equation is satisfactory, although it has some disturbing features. The fit is good, the pattern of residuals reassuring and the coefficient on (TB)(RTB) is not significantly different from its expected value of .0025. As for the CSBL variable, it should have a coefficient of 1 and its estimated value is clearly too large. Similarly the sums of AQ_i (DMSL) and BQ_i (DMSL) variables are 1.175 and 1.217 respectively, while one would expect them to be unity. Another puzzling feature of the equation is the distribution of the coefficients on the AQ_i (DMSL) variables. The indication is that interest payments on direct market issues are highest in the second and third quarters, but such a pattern is unreasonable if coupon payments are made semi-annually. Prior to 1960 the CSBL variable was relatively large in the fourth quarter. This, coupled with the high coefficient on CSBL, must be responsible to some extent for the low coefficient and relatively high standard error on AQ4 (DMSL). Despite these difficulties, however, equation (4) forecasts well. Forecasts of the interest on the debt for 1966 and 1967 were too low by $55.6 million (4.83 per cent) and $58.3 million (4.68 per cent), respectively.

A criticism of this procedure might be levelled at the complexity of the independent variables CSBL and DMSL. These will be a nuisance to forecast, as their future values must take account of the whole past debt structure. On the basis of our present approach, we can calculate the interest liabilities that equation (4) will generate into the future until such time as the last series currently outstanding has been redeemed. To this calculation must be added in each quarter the interest liability generated by gross new issues at the going market rate. Thus, if in the last observed quarter DMSL has been calculated, we can derive $DMSL_{t+1}$ by subtracting the interest liability for any issue redeemed in period t+1 and then adding the interest liability on gross new issues in period t+1. We can assume that gross new issues will be equal to the net government deficit in t+1 plus the value of the securities that will be redeemed in period t+1. Assumptions will then have to be made about the term to maturity of these gross new issues, so that we will know in what future period (t+n) they will be redeemed. Thus the liabilities series used can be projected forward logically given the net deficit, the government borrowing rate, and the desired maturity structure from the rest of the model.

PART 4 PROVINCIAL GOVERNMENT REVENUE

Total revenue of the provincial governments was $6,361 million in 1965, of which tax revenue made up 62 per cent and transfers from other levels of government (primarily the federal government) 22 per cent. In this part of the paper we present eight equations, which explain $3,598 million (or 72 per cent of total revenue excluding transfers from other levels), comprising 81 per cent of tax revenue and 41 per cent of the remaining non-tax revenue. These equations are listed in Table 12.

Our three personal direct tax equations explain 88 per cent of total provincial personal direct taxes, while our corporation income tax equation explains 92 per cent of corporate direct tax revenue, and our three indirect tax equations explain 74 per cent of total indirect tax revenue. The equation in section 3-1-6-3 covers profits of provincial government business enterprises, and explains 64 per cent of provincial investment income.

In deciding which provincial revenue sources to model, we were influenced by the relative sizes of various components, the extent to which explanatory variables were likely to be produced elsewhere in a macro-model, the availability of necessary data, and the amount of variance to be explained. Most of the items excluded are either quite small (e.g. amusement taxes) or are the product of such a jumble of rates applied to such a wide variety of tax bases (e.g. natural resources taxes and real property taxes) that little can be learned from detailed modelling. Treated as a group, however, the excluded items are easier to handle. The sum of related revenues moves fairly steadily over time, since it results from a large number of different tax rates (with substantial intertemporal and interprovincial differences) applied to a considerable range of tax bases. This cancellation of random variations is even more obvious if certain small non-tax revenues are included. For example, if all revenue items not modelled separately, except transfers from other levels of government, are

Table 12

LIST OF PROVINCIAL GOVERNMENT REVENUE ITEMS MODELLED
(Millions of dollars)

Index Code No.		1965 Revenue
	Personal Direct Taxes	
3-1-1-1	Personal income taxes	743
3-1-1-2	Motor vehicle licences and permits, persons	96
3-1-1-3	Hospital insurance premiums	187
	Corporate Direct Taxes	
3-1-3-1	Corporation income tax accruals	503
	Indirect Taxes	
3-1-4-2	Gasoline taxes	659
3-1-4-4	Motor vehicle licences and permits, businesses	139
3-1-4-7	Retail sales taxes	839
	Investment Income	
3-1-6-3	Profits of government enterprises	432
	Total	3,598

added together[51] and regressed on time and a constant term we can account for 90 per cent of the variance. The regression of that sum on GNE (RDX 223) multiplied by quarterly dummies and a time trend accounts for over 98 per cent of the variance, as shown below.

1Q48-4Q66

$$\begin{aligned} \text{SUM} = \; & \underset{(33.03)}{.01748}\,(\text{GNE}) + \underset{(4.75)}{.00218}\,\text{Q1}\,(\text{GNE}) - \underset{(4.44)}{.00192}\,\text{Q2}\,(\text{GNE}) \\ & - \underset{(9.15)}{.00370}\,\text{Q3}\,(\text{GNE}) + \underset{(18.16)}{.00015}\,(\text{GNE})(\text{T}) \end{aligned} \qquad (1)$$

SEE = 11.51 $\bar{R}^2$ = .985 D/W = 1.33

However, such a regression is an unsatisfactory means of explaining major revenue sources regardless of the fit obtained, since there is no way of using the resulting equation to indicate how and when revenues would change in response to specific changes in government policy. The method is appropriate for dealing with a heterogeneous collection of leftovers in which there is little policy interest or for which there are no suitable sources of explanatory data. But as long as we deal with the provinces as an aggregate group a number of revenue sources are best treated by an essentially defeatist regression on GNE or a trend. From time to time it will be desirable to break out specific items from the aggregate group, and attempt to develop particular models. If individual provinces wish to forecast their own revenues, then specific treatment for separate revenue items now lumped together would become at once necessary and more feasible. For the time being, we shall deal only with the larger items for which there is some homogeneity of experience across provinces.

[51]Code numbers of the items are: 3-1-1-4, 3-1-1-5, 3-1-3-2, 3-1-4-1, 3-1-4-3, 3-1-4-5, 3-1-4-6, 3-1-4-8, 3-1-6-1, 3-1-6-2, 3-1-6-4, 3-1-8-1, 3-1-8-2, 3-1-8-3, and 3-1-8-4. The last four items (which represent employer and employee contributions to pension, vacation, and compensation funds) could be modelled in the same way as the income side of the similar fund examined in section 2-1-6-1. Construction of a single model for all provinces would involve additional problems caused by aggregation of data from provinces with differing contribution rates.

One major provincial item we shall bypass is "transfers from other levels of government", because forecasting this item would not be easily improved by using the kind of econometric models that we employ in forecasting other revenue sources. Few economic or demographic variables help much to explain the outcome of negotiations on the size of transfer payments from one level of government to another.

Our approach to the explanation of provincial revenue sources has been similar to that used in the federal tax section, that is to duplicate as nearly as possible typical tax calculations underlying payments recorded in the *National Accounts*. In most cases we selected an appropriate proxy for the tax base, and then applied a weighted average tax rate. The weighting across provinces was usually done according to the distribution of the tax base among provinces. Since these weighting patterns do not usually change dramatically in the short run, the weighted rates can be regarded as predetermined variables derived from policy-determined tax rates and stable weighting patterns. In some instances, one can assume that there is a simultaneous feedback from the expenditure requirements to the tax rates. In our initial model, which treats government expenditure as being predetermined, this feedback does not prevent us from dealing with tax rates as predetermined variables. When a number of expenditure items are made endogenous to the model, some of the more volatile tax rates may have to be treated as simultaneously determined endogenous variables.

In the revenue models discussed here, we employ a number of weighted average tax rates. We describe in the data appendix the calculation procedure used in constructing each of these rates, and list the resulting series.

3-1-1-1 PERSONAL INCOME TAXES

Under the federal-provincial tax-sharing agreements of 1962 the federal government partially withdrew from the personal income tax field. The provinces were offered an abatement equal to a fixed percentage of the 'basic tax' collected.[52] Formally, the

[52]'Basic tax' is defined as total tax accruals (AY, RDX 11600) net of the Old Age Security Tax, the 1965 tax cut, the temporary surcharge imposed in 1968 and the new Social Development Tax, which took effect at the beginning of 1969.

provinces levy their own taxes at rates equal to, above, or below those of the federal abatements. The provincial tax is collected by the federal government without cost to the province——as long as the provincial tax base is identical to that of the federal government. Quebec is the one province now collecting its own personal income tax. In Table 13 we summarize the federal abatements and the provincial rates of personal income tax since 1962. The provincial levies shown for Quebec are somewhat misleading since, as already noted, Quebec has its own collection system with a separate tax base and a progressive rate structure. We assume in our analysis, however, that total Quebec tax collections do not differ significantly from the dollar value of the abatement received.[53] Manitoba and Saskatchewan each levy a surtax of 5 per cent (formerly 6 per cent) over and above the federal abatement rate, while for the other seven provinces the rates of income taxation are equal to the federal abatement rate.[54]

Two models explaining total personal tax collections were presented in section 2-1-1-1. Here we needed some method of breaking out provincial collections from the total. Our procedure was essentially the same as that used in constructing *Model 2* of section 2-1-1-1, but modified to take account of the fact that the relevant base for calculating provincial tax collections is federal basic tax, not assessed taxable income.

We proceeded by defining a new series of weighted average tax rates (BRW_i) analogous to the RW_i of section 2-1-1-1 except that we substituted basic tax payable for total tax payable in our calculations.[55] The identity

[53]In 1967 marginal tax rates in Quebec were exactly one-half of the federal marginal (basic tax) rates in each income category, although the Quebec tax base and exemption levels were not analogous to those of the federal government. *Principal Taxes and Rates 1967* issued annually by D.B.S., catalogue no. 68-201, pp. 8 and 14.

[54]Effective July 1, 1969 a 5 per cent surcharge was imposed in Alberta and in Newfoundland. New Brunswick adopted a 10 per cent surcharge effective April 1, 1969.

[55]See data appendix, pp. 155-156.

Table 13

PERSONAL INCOME TAX: RATES OF FEDERAL ABATEMENT AND PROVINCIAL TAX
(Expressed as a percentage of basic tax)

	Taxation Year						
	1962	1963	1964	1965	1966	1967	1968
Federal Abatement							
To all provinces except Quebec	16	17	18	21	24	28	28
To Quebec*	16	17	18	44	47	50	50
Provincial Levies							
Manitoba	22	23	24	26	29	33	33
Saskatchewan	22	23	24	27	29	33	33
Quebec	16	17	18	44	47	50	56
All Others	16	17	18	21	24	28	28

* In 1965 an 'opting-out' arrangement was instituted whereby a province could elect not to participate in various shared-cost programs with the federal government. Quebec opted out of several programs in return for additional abatements.

Source: *Provincial Finances*, Canadian Tax Foundation, various issues.

$$ABY = \sum_{i=1}^{4} BRW_i \, [YAS_i - NT_i \, (\overline{YEX_i})] - RDC \, (DIVC) \qquad (1)$$

was then used to define personal basic tax accruals (ABY). The YAS, NT, YEX, RDC, and DIVC variables, as well as the four income classes employed, are defined in section 2-1-1-1.

The provincial rates of personal income tax shown in Table 13 are weighted by the proportion of total tax payable originating in each province and summed to form the weighted provincial tax rate variables TPER1 for all provinces except Quebec and TPER2 for Quebec. (See the data appendix.) Total provincial accruals are then defined as

$$TPA = (TPER1 + TPER2)(ABY) \qquad (2)$$

Taxes collected by the federal government are passed on to the provinces with a two-month lag. This lag, coupled with the one-month lag between tax accruals and collections by the federal government, results in a delay of one quarter between the time provincial taxes are accrued and the time they are actually received and recorded by the provinces. Since Quebec collects its own tax we expect the lag between accruals and collections to be shorter in this instance; indeed we suspect it would be close to the one-month lag between federal accruals and collections. We thus construct the collection variable

$$\begin{aligned} TPC = {} & [(TPER1)(ABY)]_{t-1} \\ & + [1/3[(TPER2)(ABY)]_{t-1} + 2/3\ [(TPER2)(ABY)]] \end{aligned} \qquad (3)$$

Regressing actual provincial personal tax collections (TPP, DB 4051) on the calculated collection variable, we get the following equation:

2Q62-4Q66

$$TPP = \underset{(51.98)}{1.1368}\ TPC \qquad (4)$$

SEE = 14.13 $\bar{R}^2 = .959$ D/W = 1.98

This equation fits fairly well and the Durbin/Watson statistic is reassuring. Ideally we would expect the coefficient on TPC to be 1. However, our experience with the TP equation in section 2-1-1-1 indicates that a coefficient of 1.13 is not unreasonable since the independent variable, based on data in the *Taxation Statistics*, is consistently lower than the dependent variable, based on the *National Accounts*.[56]

Equation (4) allows us to assess directly the revenue effects of changes in the federal basic tax rate schedule, in the levels of abatements to the provinces, in provincial surtaxes, or in any combination of these three policy instruments. Federal personal income tax collections can be determined by deducting TPP from TP.

3-1-1-2 MOTOR VEHICLE LICENCES AND PERMITS, PERSONS
3-1-4-4 MOTOR VEHICLE LICENCES AND PERMITS, BUSINESSES

Since motor vehicles of any size can be owned either for personal or for business use, it makes sense to explain revenue from motor vehicle licences and drivers' permits, issued to persons and to businesses, as a single item (MVLP, DB 4052 + DB 4064). For this purpose we need a weighted average licence fee per registered motor vehicle, and a series representing the number of licenced vehicles. Neither is easy to develop.

Licence fees vary by province and also by type of vehicle. Since no data exist on the numbers of each type of vehicle registered in a given province, we calculated an average rate per vehicle for each province. This was done by dividing provincial revenue derived from licences and permits by the number of regis-

[56]See the discussion preceding Chart 8, pp. 43-44.

tered motor vehicles in a province. When the equation is used for forecasting, a problem arises in translating any licence fee change for a particular sort of vehicle into the appropriate change in the average rate for the province concerned. Weighting across provinces was established by using provincial net (i.e. taxable) gasoline sales. The resulting pattern of weights is stable enough to permit the equation to provide useful forecasts. Sources for all series used to compute the weighted average rate of licence fee per registered motor vehicle (MVPR), as well as values of MVPR from 1955 to 1967, are given in the data appendix.

The base we employed in constructing the MVLP equation is the total number of registered motor vehicles (RMV) as recorded in *The Motor Vehicle, Part III Registrations*.[57] A separate independent variable is required for each quarter because most licence fees are paid annually rather than quarterly. These quarterly variables were obtained by interpolating the annual RMV series (from fourth quarter to fourth quarter) and using proportional quarterly dummies. The estimated relationship is shown below.

1Q55-4Q65

$$\begin{aligned} MVLP = {} & \underset{(7.4)}{.0469}\ (MVPR)(RMV) + \underset{(66.7)}{.6126}\ Q1\ (MVPR)(RMV) \\ & + \underset{(24.0)}{.2186}\ Q2\ (MVPR)(RMV) + \underset{(2.5)}{.0226}\ Q3\ (MVPR)(RMV) \end{aligned} \qquad (1)$$

SEE = 3.546 $\qquad \bar{R}^2 = .993 \qquad$ D/W = 2.00

Equation (1) appears to be satisfactory in all respects. The sum of the quarterly coefficients is 1.041 and their pattern indicates that the bulk of licence revenue is received in the first quarter with a steady decline throughout the year. We used the equation to forecast MVLP for 1966 and 1967 with encouraging results. The 1966 forecast value was $5 million (2.03 per cent) less than the actual value and the 1967 forecast was only $2 million (.769 per cent) too low.

[57] *The Motor Vehicle, Part III Registrations* issued by D.B.S., catalogue no. 53-219.

When we attempt to use equation (1) in a macro-model, registered motor vehicles are unlikely to be endogenously determined. Sales of new passenger cars are more likely to be explained in such a model. To utilize this latter variable we created a series for the stock of passenger cars in existence (CARS). CARS is defined as a fifteen-year weighted sum of annual new car sales, with weights corresponding to U.S. scrappage rates.[58]

We reestimated the MVLP equation using the interpolated CARS series in place of RMV. The test statistics were not significantly different from those obtained for equation (1), although they were slightly inferior. The residuals were quite large in 1965, however, and when the equation was used to forecast 1966 and 1967 the forecast values of MVLP were higher than the actual values by 4.9 and 6.9 per cent respectively. This relatively poor forecasting performance is caused by a change over time in the proportion of passenger cars to the total stock of registered motor vehicles. There was a nonlinear decline in the ratio RMV/CARS from 1.58 in 1955 to 1.38 in 1965.

Employing an alternative procedure we estimated directly the relationship between RMV and CARS, and used the forecast values of RMV in equation (1) to forecast MVLP. An annual regression of RMV on CARS and CARS/T (where T is an annual time trend equal to 1 in 1955) provided the best results and is shown below.

1955-1965

$$RMV = \underset{(7.3)}{.9597} + \underset{(40.9)}{1.1906}\ CARS + \underset{(1.4)}{.0532}\ (CARS/T) \qquad (2)$$

SEE = .0418 $\qquad \bar{R}^2 = .998 \qquad$ D/W = 1.21

The equation indicates that the RMV/CARS ratio declines to an asymptotic value of 1.19. RMV was forecast for 1966 and 1967 from equation (2). The interpolated values, used in equation (1)

[58]New car sales are available from *New Motor Vehicle Sales* issued monthly by D.B.S., catalogue no. 63-007. Scrappage rates are given in Friedman, Charles S.: "Stocks of Passenger Cars: Postwar Growth and Distribution." In: *Survey of Current Business*, U.S. Department of Commerce, September 1963, p. 20.

produced revenue forecasts for MVLP that were only $3 million too low in 1966 and $1 million too high in 1967.

3-1-1-3 HOSPITAL INSURANCE PREMIUMS

Under the federal Hospital Insurance and Diagnostic Services Act of 1957, the costs of hospitalization are shared approximately equally by the federal and provincial governments. Since the provinces are free to devise their own methods for financing the provincial share of these costs, a variety of financing methods are in use. Three provinces——Ontario, Manitoba and Saskatchewan——require the payment of hospital insurance premiums. These revenues appear under "Direct Taxes" in the *National Accounts*.

To estimate the aggregate premium receipts, we needed a weighted average rate of premium (with zero weights for provinces other than Ontario, Manitoba and Saskatchewan), and a measure to represent the insured population. We prepared our weighted average premium rate (RWH) by weighting according to the provincial share of the national civilian labour force (NL, RDX 11141) and therefore the appropriate base figure is NL. We chose NL as our base because most of the insured population is insured through payroll deductions——coverage is a condition of employment in many firms. If we regress total hospital insurance premiums (HIP, DB 4053) on RWH (NL) the coefficient could differ from 1 because the number of insured persons not in the civilian labour force may be either more or less than the number of uninsured persons in the civilian labour force.

To calculate a weighted average premium rate, an average premium for each province was first obtained by multiplying the premium for married contributors by the proportion of married males in the provincial labour force and adding the product of the premium for single contributors multiplied by the proportion of single persons in the provincial labour force.[59] The average premium for a particular province was then weighted by that prov-

[59]We assume that all married females in the labour force have husbands who are also in the labour force. The category 'single persons in the labour force' includes those who are widowed or divorced. The relevant provincial proportions are derived from 1961 census data and assumed to be constant throughout the estimation period.

ince's share in the national civilian labour force. Summing over the three provinces requiring premium payments gave a weighted average hospital insurance premium rate for Canada.

The use of quarterly dummy variables was considered to be necessary because of the method of making premium payments in Saskatchewan. Payments in Ontario and Manitoba are made on a quarterly or monthly basis, generally through payroll deductions. In Saskatchewan however, contributors assessed at the single rate must pay at least one-half of the premium on November 30 and the balance on the following May 31; contributors assessed at the married rate may make bulk payments in November or may pay in quarterly instalments. One would therefore expect the total fourth-quarter premium receipts to be consistently larger than those received in the previous three quarters. While the anticipated results were obtained, the relative magnitudes involved are not great owing to the small number of single contributors in Saskatchewan compared with total contributors in all provinces. Another reason for expecting the coefficient to be lower in the second and third quarters is that any seasonal increase in the labour force would not necessarily be matched by an equivalent increase in the insured population, since some seasonal workers would remain uninsured, while others would maintain their insurance even when out of the labour force.

We present below our estimated equation.

1Q59-4Q66

$$\begin{aligned} HIP = & \underset{(55.3)}{1.1627}\ Q1\ (RWH)(NL) + \underset{(54.9)}{1.1243}\ Q2\ (RWH)(NL) \\ & + \underset{(55.1)}{1.0447}\ Q3\ (RWH)(NL) + \underset{(59.9)}{1.1644}\ Q4\ (RWH)(NL) \end{aligned} \tag{1}$$

SEE = 1.795 $\quad\quad \bar{R}^2 = .949 \quad\quad$ D/W = 1.69

The quarterly pattern of coefficients is the pattern we expected. The average of the quarterly coefficients is 1.124 indicating that there are more insured people outside the labour force than uninsured people in the labour force. Since about 98 per cent of

the population in Ontario, Manitoba and Saskatchewan is insured, the high coefficients were expected. Because of differing family sizes the proportion of the labour force insured can, of course, be higher or lower than 98 per cent. The forecast value of HIP for 1967 was $2 million (1.010 per cent) higher than the actual value. For 1968 the equation produced a value $2 million (.667 per cent) lower than the actual value of HIP.

3-1-3-1 CORPORATION INCOME TAX ACCRUALS

In the federal tax sector we presented equations for total and federal corporation income tax accruals (section 2-1-2) and for the corresponding corporation tax collections (section 2-3-2-6). In this section we explain the provincial share of the corporation income tax on an accrual basis.

For total corporation tax accruals (TCA) it was possible to estimate a structural equation, since we have some knowledge of the structure of the tax as well as direct survey data on both total corporation profits and total corporation tax accruals. For provincial tax accruals, however, no suitable data are available.[60] This leaves us with a choice of two procedures. Since we have equations for total accruals and federal accruals as they appear in the *National Accounts*, we can obtain a series for provincial accruals as a residual. The series obtained in this way (PCAR) would correspond to the national accounts series on provincial accruals. Alternatively, we can create a series for provincial corporation accruals (PCA) based on our a priori information about the structure of the tax. Since in any one province there is only a single rate at which corporations pay provincial income tax and since this rate is applied directly to taxable corporate profits, it is fairly easy to calculate a series for provincial accruals according to the identity

$$PCA = PCTR\ (PCT) \qquad (1)$$

where PCT is taxable corporation profits generated from national accounts profits (PC) according to the relationship

[60]See p. 62.

$$PCT = .7591\ PC + 7.8168\ T + 125.1337 \qquad (2)$$

discussed fully in section 2-1-2.

PCTR is a weighted average of provincial corporation income tax rates. Between 1947 and 1951 eight of the provinces received a transfer from the federal government equal to 5 per cent of taxable corporation profits collected in their jurisdictions; Ontario and Quebec collected their own corporation profits tax at a rate of 7 per cent. In 1952 Ontario rented its corporation tax field to the federal government; Quebec continued to levy the 7 per cent rate until 1957. Under the terms of the Federal-Provincial Tax-Sharing Arrangements Act of 1957 the provinces received either a transfer of 9 per cent of taxable corporation profits accruing in a province, or an equal abatement of federal tax. Quebec and Ontario took the abatement. In addition Ontario levied a tax of 11 per cent on corporation profits. The remaining provinces took the transfer. From 1962 to 1967 all provinces except Quebec received a federal abatement of 9 per cent; Quebec received an extra 1 per cent in lieu of federal grants toward the support of universities in that province. During these abatement agreements both Ontario and Quebec had rates that were 2 per cent greater than the abatement, while Manitoba and Saskatchewan levied an extra 1 per cent. All the other provinces re-entered the corporation tax field under the 1962 agreements with rates equal to the 9 per cent abatement. In 1967 this abatement was increased to 10 per cent for all provinces. We weighted these provincial rates by the proportion of taxable corporation profits in each province to get PCTR. Values for PCTR are given in the data appendix.

The use of equation (1) to calculate PCA implies that federal accruals are given as a residual (FCAR).[61] Values for PCA and FCAR obtained in this way appear in the data appendix. It should be noted that these series differ from their national accounts counterparts. Since no direct observations underlie either set

[61]See footnote 33, p. 63.

of accrual series one's choice should depend on the plausibility of the derivation procedure and on how they perform in experiments that can discriminate between the two series.[62]

3-1-4-2 GASOLINE TAXES

In generating a gasoline tax equation we attempted to duplicate as closely as possible the tax calculations involved in arriving at the national accounts totals. Our basic equation is of the form

$$GTAX = RWG\ [(GAS/CARS)\ CARS] + RWD\ [(DO/CV)\ CV] \quad (1)$$

where:

GTAX = gasoline tax receipts, millions of dollars (DB 4062)

RWG = weighted average gasoline tax rate, dollars per gallon

RWD = weighted average diesel oil tax rate, dollars per gallon

GAS = taxable sales of gasoline, millions of gallons

DO = taxable sales of diesel oil, millions of gallons

CARS = stock of existing passenger automobiles, millions

CV = commercial vehicle registrations, millions

We constructed a gasoline tax model that leaves only CARS, RWG and RWD exogenous to the government sector. CARS is a Bank of Canada series generated by applying U.S. scrappage rates to Canadian new car sales. (See section 3-1-4-4, p. 126.) To calculate RWG we weighted the gasoline tax rate in a particular province by that province's share in taxable sales of gasoline. Similarly we calculated RWD by weighting the diesel oil tax rate by taxable

[62]One such experiment is suggested and reported in section 2-3-2-6, pp. 79-80.

sales of diesel oil. Sources for the data used to compile RWG and RWD, as well as the values of these weighted rates from 1959 to 1967, are given in the data appendix.

Our initial step in constructing the gasoline tax model was to generate a series that approximates CV and that can be readily forecast. The ratio CV/CARS declines nonlinearly from .40 in 1955 to .27 in 1967, and an annual regression similar to that used to forecast RMV in section 3-1-4-4 produced the following results:

1955-1966

$$\underset{(11.69)}{CV = .4494} + \underset{(23.00)}{.1861\ CARS} + \underset{(2.26)}{.0276\ (CARS/T)} \qquad (2)$$

SEE = .0145 $\qquad \bar{R}^2 = .990 \qquad$ D/W = 1.96

Quarterly values of CV used in equation (1) (denoted $\hat{CV}$) were generated by using the coefficients of equation (2) with the CARS series linearly interpolated from fourth quarter to fourth quarter and with T a step trend, equal to 1 in all quarters of 1955, 2 in all quarters of 1956, etc.

Next, we needed equations with which to forecast the ratios GAS/CARS and DO/CV. As one would expect the ratio GAS/CARS is almost constant over the time period, a factor that led to the following equation:

1Q59-4Q66

$$\begin{aligned} GAS/CARS = {} & \underset{(85.15)}{169.1217\ Q1} + \underset{(110.21)}{218.9053\ Q2} \\ & + \underset{(125.93)}{250.1134\ Q3} + \underset{(105.65)}{209.8438\ Q4} \end{aligned} \qquad (3)$$

SEE = 5.618 $\qquad \bar{R}^2 = .965 \qquad$ D/W = 1.77

These coefficients indicate the number of gallons of gasoline used per existing passenger car in each quarter. The quarterly pattern is predictable, with the highest average gasoline consumption

occurring in the third quarter and the lowest in the first quarter. Although the coefficients seem high some upward bias is to be expected, since the denominator does not include all gasoline-burning vehicles.

The following equation, used to forecast the DO/CV ratio, proved to be slightly more difficult to construct than equation (3) because of the more intensive use of capital (CV), reflected in the rapid increase of the ratio over the 1962-1966 period.

1Q59-4Q66

$$\begin{aligned} DO/CV = {} & \underset{(14.71)}{25.5043} + \underset{(1.97)}{.4305}\,(T1)(Q1) - \underset{(.74)}{.1582}\,(T1)(Q2) \\ & + \underset{(3.28)}{.6842}\,(T1)(Q3) + \underset{(3.61)}{.7271}\,(T1)(Q4) + \underset{(1.45)}{.0201}\,(T1)(T2)(Q1) \qquad (4) \\ & + \underset{(4.47)}{.0572}\,(T1)(T2)(Q2) + \underset{(1.57)}{.0185}\,(T1)(T2)(Q3) + \underset{(.85)}{.0092}\,(T1)(T2)(Q4) \end{aligned}$$

$SEE = 3.419$ $\qquad$ $\bar{R}^2 = .887$ $\qquad$ $D/W = 1.66$

T1 is a time trend equal to 1 in 1Q59 and continuing to 4Q66. T2 is a second time trend inserted to capture the increase in the ratio referred to above. T2 equals 1 in 1Q62 and continues to 4Q66. One would not expect this rate of increase to be maintained indefinitely. A close watch should therefore be kept on the forecast values of equation (4) to try to ascertain when T2 should stop rising.

Using the calculated values from equations (2), (3) and (4) along with the exogenous series for RWG, RWD and CARS, we estimated equation (1) with the following results:

1Q59-4Q66

$$GTAX = \underset{(105.11)}{1.0061} \left[RWG \left(\frac{\widehat{GAS}}{CARS}\right) CARS + RWD \left(\frac{\widehat{DO}}{CV}\right) \widehat{CV}\right] \quad (5)$$

SEE = 7.283 $\bar{R}^2$ = .958 D/W = 2.35

The fit of equation (5) is good with the coefficient not significantly different from 1. We used the model to forecast GTAX for 1967 and the forecast value exceeded the actual value by $5 million (.644 per cent).

The gasoline tax model presented above should be useful both for straight forecasting and for policy analysis using a macro-model, since the only exogenous variables are weighted tax rates and the number of cars existing. It appears that the weights are stable enough to allow RWG and RWD to be easily forecast. Since scrappage rates are assumed to be predetermined, one can derive the CARS series from any model that has a demand equation for automobiles.

3-1-4-7 RETAIL SALES TAXES

The retail sales tax (TRS, DB 4067) is simple to model, as a variable much like the actual tax base is explained within most macro-models. Our base is the sum of current-dollar consumer expenditures on durables (CD, DB 243) and nondurables (CND, DB 242). The weighted sales tax rate (RWS) is obtained by weighting each provincial rate by that province's proportion of retail trade. Since receipts from the retail sales tax are remitted by merchants and recorded by the governments as tax receipts in the month following the sales of the relevant goods,[63] both the weighted rate and the base series must be lagged one month. This can be done easily for the rate, because the weights are available from a monthly

[63]In Saskatchewan the taxes are remitted and recorded during the month following the end of the quarter in which goods are sold. In our estimation procedure, apart from the calculation of the weighted rate variable, no special allowance was made for this situation.

series.[64] For the base series, however, only quarterly data are available. Therefore, to approximate this lag we defined a new expenditure variable equal to two-thirds of actual expenditure in the current quarter plus one-third of expenditure in the preceding quarter. By making these adjustments to capture the lags in the collection and recording procedures, we obtained a closely-fitting equation without the aid of dummy seasonals. Since the national accounts expenditure series are adjusted to include the amount of retail sales tax collected, they must be divided by (1 + RWS) to obtain an estimate of the tax base. Thus our equation is:

1Q52-4Q66

$$\underset{(102.01)}{\mathrm{TRS} = 1.13952\ \mathrm{RWS}} \left[\frac{1/3\ (\mathrm{CD} + \mathrm{CND})_{t-1} + 2/3\ (\mathrm{CD} + \mathrm{CND})}{1 + \mathrm{RWS}}\right] \quad (1)$$

SEE = 8.942 $\qquad \bar{R}^2 = .985 \qquad$ D/W = 1.80

Many taxable sales of secondhand goods are only partially included[65] in CD + CND, and a special sales tax on tobacco and tobacco products is not covered in our weighted rate variable. Offsetting these items are a number of expenditures included in the base series, but not subject to tax. These comprise small purchases (those under 10, 15 or 20 cents depending on the province concerned), foodstuffs, and in some provinces, meals, drugs, some fuels and a variety of miscellaneous items. Our coefficient indicates that the receipts from the tobacco tax and the tax on sales of secondhand goods more than outweigh the effect of exempt items included in the expenditure series.

[64]Total retail trade by province was obtained from *Retail Trade* issued monthly by D.B.S., catalogue no. 63-005. Prior to 1961 our trade figures are based on the 1949 Standard Industrial Classification; from 1961 on they are based on the 1960 SIC. The weights do not appear to be affected by these revisions and, indeed, are remarkably stable over the 1952-1968 period.

[65]Sales of used consumer durables from the business sector to the personal sector are reduced by the estimated value of trade-in allowances received by consumers. See *National Accounts, Income and Expenditure, 1926-1956* issued by D.B.S., catalogue no. 13-502, p. 158.

Forecast values for TRS generated with equation (1) were \$5 million (.394 per cent) too high in 1967 and \$67 million (4.400 per cent) too low in 1968.

3-1-6-3 PROFITS OF GOVERNMENT ENTERPRISES

Provincial governments engage in a wide range of enterprises, from the sale of liquor to the operation of near-banks, with a heavy emphasis on utilities. Given the monopolistic nature of many of these enterprises and the relative stability of demand for the goods and services involved, one would expect trading profits (PGTP, DB 4072) to be less volatile than the profits of private corporations (PC, RDX 226) though more volatile than GNE (RDX 223). If this were so both variables should help to determine provincial government trading profits. Since there is no reason to expect these relationships to be independent of the seasons, one should allow some of the coefficients to take different values in each quarter.

We experimented with two basic specifications—the first using GNE and quarterly dummies proportional to PC, and the second using PC with seasonal differences proportional to GNE. The latter specification was marginally superior but in general the coefficients on PC were not significant. We present the two equations below, as well as a third one using GNE alone to explain PGTP.

1Q51-4Q65

$$\begin{aligned} PGTP = \underset{(13.30)}{.00780}\ GNE + \underset{(1.01)}{.00640}\ Q1\ (PC) - \underset{(.24)}{.00128}\ Q2\ (PC) \\ - \underset{(1.36)}{.00863}\ Q3\ (PC) + \underset{(3.11)}{.01826}\ Q4\ (PC) \end{aligned} \qquad (1)$$

SEE = 3.666 $\bar{R}^2$ = .969 D/W = 2.00

1Q51-4Q65

$$
\begin{aligned}
PGTP = {} & \underset{(.93)}{.00538\ PC} + \underset{(14.51)}{.00791\ Q1\ (GNE)} + \underset{(10.85)}{.00704\ Q2\ (GNE)} \\
& + \underset{(11.91)}{.00649\ Q3\ (GNE)} + \underset{(15.44)}{.00911\ Q4\ (GNE)}
\end{aligned}
\tag{2}
$$

SEE = 3.563 $\bar{R}^2$ = .970 D/W = 2.02

1Q51-4Q65

$$
\begin{aligned}
PGTP = {} & \underset{(94.69)}{.00965\ GNE} - \underset{(7.95)}{.00124\ Q1\ (GNE)} \\
& - \underset{(13.59)}{.00201\ Q2\ (GNE)} - \underset{(19.19)}{.00266\ Q3\ (GNE)}
\end{aligned}
\tag{3}
$$

SEE = 3.559 $\bar{R}^2$ = .970 D/W = 1.96

DATA APPENDIX

2-1-1-1 PERSONAL INCOME TAX

A. Total Personal Income Tax Collections (TP): Deductions at Source (TPS) and Other Collections (TPO)

Using *Model 1* and *Model 2* we attempted to estimate national accounts income tax collections, net of refunds (TP, DB 1368). Unfortunately this series is not divided into its constituent series, deductions at source (TPS) and other collections (TPO), which we require for *Model 1*. To obtain values for these variables we used the two budgetary series "Total Personal Income Taxes Collected, Gross Excluding Refunds, Deductions at Source" and "Total Personal Income Taxes Collected, Gross Excluding Refunds, Other Collections". These monthly series are available in the Research Department of the Bank of Canada. The aggregate of the two series differs from the national accounts series in two respects. The first difference is that Quebec's share of the personal income tax is not included in budgetary revenues since it is collected directly by the province. The second, but minor, difference arises from the treatment of supplementary period revenues, received in April but recorded as March budgetary revenues. In the *National Accounts* these revenues are recorded in April. This latter difference does not affect annual revenues, but it makes the first- and second-quarter amounts different under the two accounting procedures.

To reconcile the budgetary series with the national accounts series we calculated the difference between the two [TP - (TPS + TPO)], and allocated this difference to TPS and TPO in the proportions

$$TPS/(TPS + TPO)$$

$$\text{and } TPO/(TPS + TPO)$$

respectively. After spreading the difference in this way the series used in equations (1.2) and (1.4) are:

DEDUCTIONS AT SOURCE, NET OF REFUNDS (TPS)
(Millions of dollars)

	1Q	2Q	3Q	4Q
1950	80	42	85	96
1951	108	91	152	178
1952	189	143	208	237
1953	226	161	226	240
1954	223	148	247	261
1955	235	152	258	267
1956	256	175	309	328
1957	310	226	347	364
1958	304	150	319	336
1959	295	204	377	401
1960	342	278	412	426
1961	360	291	442	462
1962	399	334	486	513
1963	451	325	513	567
1964	504	427	625	664
1965	611	477	687	733
1966	736	521	818	919
1967	1,027	606	1,045	1,157
1968	1,227	752	1,232	1,418

OTHER COLLECTIONS, NET OF REFUNDS (TPO)
(Millions of dollars)

	1Q	2Q	3Q	4Q
1950	64	142	52	51
1951	71	177	57	56
1952	77	189	71	63
1953	86	220	65	63
1954	75	211	67	64
1955	75	184	64	62
1956	75	216	73	64
1957	83	219	79	65
1958	76	225	75	70
1959	80	240	77	70
1960	87	273	88	73
1961	94	295	98	83
1962	104	293	101	86
1963	105	321	115	90
1964	120	374	131	112
1965	135	437	143	132
1966	165	447	163	134
1967	187	561	179	143
1968	214	664	220	195

B. Exogenous Spreading Ratios (N_i, W_i, NW_i, Y_i)

Data used to calculate the N_i, W_i, NW_i and Y_i ratios are obtained from tables in the Department of National Revenue's annual publication, *Taxation Statistics, Part One (Individuals).* The values of the ratios presented in the following tables are annual values. When these ratios are used in the tax models a quarterly pattern is imparted to them by means of simple linear interpolation from fourth quarter to fourth quarter.

PROPORTION OF TOTAL TAX RETURNS FILED IN EACH INCOME CLASS (N_i)
($N_i = NT_i/NT$)

	N1	N2	N3	N4
1950	.806	.150	.032	.011
1951	.731	.213	.043	.012
1952	.677	.258	.052	.014
1953	.644	.280	.062	.014
1954	.642	.280	.064	.014
1955	.620	.292	.073	.016
1956	.577	.312	.095	.017
1957	.557	.315	.110	.018
1958	.529	.327	.122	.021
1959	.511	.327	.140	.022
1960	.496	.324	.156	.024
1961	.485	.318	.170	.027
1962	.461	.318	.191	.029
1963	.454	.308	.206	.032
1964	.431	.300	.233	.036
1965	.414	.285	.260	.041
1966	.394	.272	.284	.050
1967	.377	.256	.306	.061

PROPORTION OF ASSESSED WAGE INCOME IN EACH INCOME CLASS (W_i)
(W_i = WAS_i/WAS)

	W1	W2	W3	W4
1950	.647	.246	.065	.042
1951	.538	.331	.085	.045
1952	.462	.388	.103	.046
1953	.418	.412	.124	.047
1954	.404	.413	.132	.051
1955	.378	.421	.149	.052
1956	.332	.428	.188	.053
1957	.305	.419	.217	.060
1958	.279	.420	.234	.067
1959	.257	.407	.266	.070
1960	.238	.393	.293	.076
1961	.225	.378	.314	.083
1962	.205	.362	.345	.088
1963	.197	.343	.365	.096
1964	.177	.319	.400	.104
1965	.160	.289	.435	.116
1966	.138	.259	.464	.139
1967	.121	.231	.484	.164

PROPORTION OF ASSESSED NONWAGE PERSONAL INCOME IN EACH INCOME CLASS (NW_i)
(NW_i = $NWAS_i$/NWAS)

	NW1	NW2	NW3	NW4
1950	.357	.178	.194	.271
1951	.317	.197	.208	.278
1952	.300	.201	.213	.286
1953	.286	.206	.225	.284
1954	.291	.195	.212	.302
1955	.270	.191	.214	.325
1956	.253	.195	.232	.321
1957	.243	.194	.237	.326
1958	.223	.206	.242	.330
1959	.213	.208	.242	.337
1960	.209	.209	.242	.340
1961	.201	.201	.247	.352
1962	.181	.205	.252	.363
1963	.179	.196	.257	.368
1964	.162	.188	.263	.388
1965	.147	.176	.267	.410
1966	.147	.182	.271	.400
1967	.140	.163	.264	.433

PROPORTION OF ASSESSED INCOME IN EACH INCOME CLASS (Y_i)
($Y_i = YAS_i/YAS$)

	Y1	Y2	Y3	Y4
1950	.588	.232	.091	.089
1951	.495	.305	.110	.091
1952	.431	.352	.124	.092
1953	.393	.373	.143	.091
1954	.384	.375	.146	.095
1955	.359	.381	.161	.100
1956	.318	.388	.196	.099
1957	.294	.382	.220	.104
1958	.269	.383	.235	.113
1959	.249	.373	.262	.116
1960	.233	.362	.285	.121
1961	.221	.347	.302	.129
1962	.201	.335	.329	.134
1963	.194	.319	.347	.141
1964	.175	.297	.376	.152
1965	.158	.270	.407	.165
1966	.140	.245	.429	.186
1967	.125	.219	.445	.211

C. Weighted Average Personal Income Tax Rates

The average tax rates for the i^{th} income class are found by calculating the tax payable (using the current rate schedule) on the mean taxable income in j groups of the i^{th} class. The average group tax rate is then the ratio of tax payable to mean taxable income in that group. To obtain a class weighted average (RW_i), group averages are weighted by the ratio of assessed income taxable in the group (that is, total assessed income of those filing returns who did pay some tax) to assessed income taxable in the class concerned and summed over all groups. Thus

$$RW_{it} = \sum_{j=1}^{n} [(T_{jit}/\overline{YT}_{jit})(YAST_{jit}/YAST_{it})] \quad (i=1,2,3,4)$$

where:

RW_{it} = weighted average personal income tax rate, class i, year t.

T_{jit} = tax on mean taxable income in group j, class i,

year t, calculated by using the rate schedule applicable in year t.

$\overline{YT}_{jit}$ = mean taxable income in group j, class i, year t.

$YAST_{jit}$ = total assessed income taxable in group j, class i, year t.

$YAST_{it} = \sum_{j=1}^{n} YAST_{jit}$; total assessed income taxable, class i, year t.

Calculating T_{jit} using income groups within the four income classes enabled us to capture most of the progression in the rate schedule. The larger is n (that is, the more groups employed in any one class) the more precise the estimate of RW_i. In this calculation we used \$1,000 groups up to the \$10,000 level of assessed income,[66] and \$5,000 groups up to the \$25,000 level. The remaining incomes we divided into two groups, \$25,000-\$50,000 and over \$50,000. Hence n = 2 in Class 1 and Class 2, and n = 5 in Class 3 and Class 4.

The rates do not include provincial levies in excess of the standard federal rates. Amounts would not be great, however, since only Quebec had higher rates between 1954 and 1961, and following the 1962 taxation agreements only Manitoba and Saskatchewan levied an extra tax on personal income.[67]

Annual values for RW_i are given in the following table. The annual value is used in each quarter of the year.

[66]Except for assessed income between zero and \$2,000, which we treated as one group.

[67]Saskatchewan levied a 6 per cent surcharge from 1962 to 1965, then a 5 per cent surcharge from 1966 to 1968. In Manitoba the surcharge was 6 per cent from 1962 to 1964, and 5 per cent from 1965 to 1968. Quebec introduced a 6 per cent surcharge in 1968.

WEIGHTED AVERAGE PERSONAL INCOME TAX RATES (RW_i)
(Percentages)

	RW1	RW2	RW3	RW4	Overall Weighted Average
1950	15.0	15.6	18.0	30.8	17.3
1951	16.5	17.2	19.8	33.9	19.0
1952	18.5	19.3	21.6	35.7	21.1
1953	18.0	18.8	20.6	32.8	20.3
1954	17.0	17.7	19.3	30.9	19.2
1955	16.0	16.8	18.3	30.0	18.3
1956	15.0	15.9	17.3	28.8	17.4
1957	15.0	15.9	17.3	28.3	17.4
1958	13.0	14.2	16.4	27.8	16.3
1959	13.5	14.8	17.0	28.5	16.9
1960	14.1	15.3	17.6	29.2	17.7
1961	14.0	15.4	17.6	29.0	17.8
1962	14.0	15.4	17.5	28.5	17.9
1963	14.1	15.5	17.6	28.2	18.0
1964	15.2	16.6	18.5	28.7	19.1
1965	14.7	16.1	17.8	27.5	18.7
1966	13.6	15.7	17.7	27.2	18.6
1967	13.3	16.0	19.3	28.6	20.1
1968(E)*	13.3	16.1	19.6	29.3	20.6
1969(E)	15.3	18.1	21.6	30.3	22.5

*(E) = a forecast estimate

D. Average Utilized Exemptions and Deductions for Each Income Class

The average level of exemptions and deductions per tax return in each income class ($\overline{EX}_i$) is exogenous to both income tax models. It is possible to estimate these series within the models, but a number of experiments with various types of equations suggested this could not be done simply enough to justify inclusion in our initial specification. The series is merely EX_i/NT_i——total class exemptions and deductions per taxpayer in the class. Annual values are as follows:

AVERAGE UTILIZED EXEMPTIONS AND DEDUCTIONS ($\overline{EX}_i$)
(Dollars)

	$\overline{UEX1}$*	$\overline{EX2}$	$\overline{EX3}$	$\overline{EX4}$	Overall Weighted Average
1950	1,404	2,256	2,397	2,712	1,579
1951	1,361	2,232	2,429	2,730	1,609
1952	1,325	2,203	2,438	2,915	1,631
1953	1,294	2,180	2,461	2,986	1,638
1954	1,272	2,200	2,476	3,050	1,634
1955	1,260	2,177	2,463	3,154	1,645
1956	1,250	2,140	2,450	2,962	1,669
1957	1,262	2,170	2,499	3,118	1,718
1958	1,282	2,301	2,668	3,360	1,828
1959	1,259	2,262	2,666	3,366	1,831
1960	1,243	2,240	2,654	3,421	1,839
1961	1,243	2,217	2,659	3,450	1,854
1962	1,218	2,237	2,698	3,480	1,892
1963	1,213	2,207	2,698	3,553	1,900
1964	1,191	2,143	2,670	3,605	1,908
1965	1,152	2,068	2,628	3,570	1,896
1966	1,142	2,017	2,614	3,643	1,922
1967	1,111	1,913	2,524	3,649	1,904

*Average exemptions in Class 1 are adjusted for the unutilized part of nontaxpayers' total exemptions and deductions.

In Class 1 (\$0-\$3,000) we must adjust $\overline{EX1}$ to take into account the nontaxable returns (that is, returns on which the amount of eligible exemptions and deductions exceeds assessed income). Here the only exemptions actually utilized are the amounts necessary to offset reported income; any excess over these amounts lapses. Average exemptions in Class 1 therefore must be adjusted downward. To arrive at the adjustment factor we calculated PE1, the proportion of utilized exemptions in Class 1. PE1 can be derived from data in the *Taxation Statistics*. It is equal to the ratio of utilized exemptions——total exemptions claimed by taxpayers plus total assessed income that is nontaxable——to total exemptions, taxable plus nontaxable. Thus

$$PE1 = \frac{EX1\ (\text{taxable}) + YAS1\ (\text{nontaxable})}{EX1\ (\text{taxable}) + EX1\ \ (\text{nontaxable})}$$

The average utilized exemption series, $\overline{UEX1}$, is then equal to

$$PE1\ (EX1/NT1)$$

No utilization adjustments are needed in the other classes as most nontaxable returns fall in Class 1. Therefore $PE_i = 1, i = 2, 3, 4$.

CALCULATED VALUES FOR PE1

1950	.852	1959	.807
1951	.855	1960	.799
1952	.851	1961	.800
1953	.844	1962	.795
1954	.825	1963	.800
1955	.824	1964	.803
1956	.840	1965	.794
1957	.826	1966	.788
1958	.810	1967	.779

To obtain $\overline{WEX_i}$, $\overline{NEX_i}$, and $\overline{YEX_i}$, which are the quarterly values of the annual $\overline{EX_i}$ series, and which, in turn, are used in the accrual equations of *Model 1* and *Model 2*, $\overline{EX_i}$ is spread by a ratio of estimated quarterly assessed income to annual assessed income. For the wage equation (1.1) $W\hat{A}S$ would be used to derive the spreading ratio, while in equations (1.3) and (2.1) $NW\hat{A}S$ and $Y\hat{A}S$ would be used, respectively. The ratios are, in effect, quarterly proportions giving a quarterly pattern to an annual value. $\overline{EX_i}$, therefore, is made to vary quarterly in proportion to the relevant income variations. These spreading ratios are given below.

RATIO OF QUARTERLY $\hat{WAS}$ TO ANNUAL $\hat{WAS}$

	1Q	2Q	3Q	4Q
1950	.233	.243	.256	.268
1951	.231	.245	.258	.266
1952	.238	.243	.255	.264
1953	.240	.248	.256	.255
1954	.240	.247	.256	.257
1955	.236	.246	.258	.260
1956	.230	.247	.261	.262
1957	.236	.249	.260	.255
1958	.238	.251	.257	.254
1959	.239	.250	.255	.256
1960	.239	.251	.257	.253
1961	.237	.250	.258	.256
1962	.237	.250	.257	.255
1963	.237	.249	.257	.258
1964	.235	.248	.258	.259
1965	.232	.247	.258	.263
1966	.234	.247	.258	.261
1967	.236	.248	.257	.259
1968	.233	.247	.258	.262

RATIO OF QUARTERLY $\hat{NWAS}$ TO ANNUAL $\hat{NWAS}$

	1Q	2Q	3Q	4Q
1950	.185	.208	.376	.232
1951	.171	.235	.374	.221
1952	.183	.195	.391	.231
1953	.183	.213	.386	.218
1954	.206	.229	.319	.246
1955	.200	.229	.347	.224
1956	.193	.221	.356	.229
1957	.210	.228	.317	.245
1958	.216	.233	.310	.241
1959	.217	.238	.311	.234
1960	.224	.228	.308	.240
1961	.232	.235	.283	.250
1962	.219	.237	.307	.238
1963	.210	.234	.317	.239
1964	.230	.229	.297	.243
1965	.231	.220	.305	.244
1966	.227	.217	.313	.243
1967	.236	.227	.289	.248
1968	.220	.234	.298	.248

RATIO OF QUARTERLY $\hat{YAS}$ TO ANNUAL $\hat{YAS}$

	1Q	2Q	3Q	4Q
1950	.205	.226	.314	.255
1951	.199	.241	.312	.248
1952	.211	.222	.316	.251
1953	.214	.234	.312	.240
1954	.224	.240	.283	.253
1955	.217	.239	.296	.248
1956	.212	.237	.300	.251
1957	.224	.242	.283	.250
1958	.227	.244	.280	.249
1959	.227	.246	.279	.248
1960	.231	.242	.279	.248
1961	.232	.244	.270	.255
1962	.227	.245	.279	.249
1963	.223	.243	.282	.251
1964	.231	.241	.274	.254
1965	.230	.237	.277	.257
1966	.230	.236	.279	.255
1967	.235	.240	.270	.255
1968	.227	.242	.274	.257

2-1-2 CORPORATION INCOME TAX ACCRUALS

Data used for the calculation of non-databank variables in this section are obtained from *Taxation Statistics, Part Two (Corporations)*,[68] where statistics are presented on a fiscal year basis. However recent issues of this publication include an historical table showing most of the data on a calendar year basis. Wherever possible we have used calendar year data.

A. Weighted Marginal (Federal and Provincial) Corporation Tax Rate (RPC1)

There are two rates of tax at the federal level. The low rate (currently 21 per cent) is paid on taxable profits up to a low-rate maximum ($35,000 from 1961 to the present), and the high rate (currently 50 per cent) is paid on the remaining profits. To calculate RPC1 we assumed that all firms paying tax at the high rate (HR) on part of their taxable income pay this rate on

[68]See footnote 29, p. 58.

all their taxable income. We then have

$$RPC1U = \frac{(HR)\ PCTH + (LR)\ PCTL}{PCT}$$

where:

RPC1U = weighted marginal rate, unadjusted for provincial levies

HR = high rate of taxation

LR = low rate of taxation

PCTH = taxable corporation profits of firms that pay at the high rate

PCTL = taxable corporation profits of firms that pay at the low rate

PCT = PCTH + PCTL——total taxable corporation profits

No data are available on the disaggregation of taxable corporation profits between high-rate and low-rate firms, but we do have observations on current-year profits (CYP) for these two categories of firms from Table 6 of *Taxation Statistics, Part Two*. We also know that

$$PCT = CYP - PYL$$

where PYL is prior-year losses. Analysis of Table 2 in *Taxation Statistics, Part Two* reveals that the ratio of prior-year losses of high-rate to low-rate firms has been fairly constant at .25. We thus calculate PCTH and PCTL as

$$PCTH = CYPH - .20\ PYL$$

$$PCTL = CYPL - .80\ PYL$$

where CYP = CYPH + CYPL.

Finally, to arrive at RPC1 we must adjust RPC1U to reflect any provincial levies that exceed allowable provincial tax credits.

From 1957 to 1967 Ontario levied corporation taxes at a rate 2 per cent greater than the allowed abatement. Manitoba and Saskatchewan levied an extra 1 per cent from 1962 to 1967 while Quebec levied an additional 2 per cent. In 1967 Newfoundland levied an additional 1 per cent. These extra levies are weighted by the proportion of total taxable corporation profits in each of the respective provinces (Table 7, *Taxation Statistics, Part Two*), and the weighted provincial excess (WPE) is added to RPC1U to give RPC1. Data values from 1952 to 1967 appear below. The annual rate is assumed to hold in each quarter.

WEIGHTED MARGINAL CORPORATION INCOME TAX RATES

	RPC1U	WPE	RPC1
1952	.515	.015	.530
1953	.476	.015	.491
1954	.472	.016	.488
1955	.451	.016	.467
1956	.448	.016	.464
1957	.444	.009	.453
1958	.444	.009	.453
1959	.473	.009	.482
1960	.472	.009	.481
1961	.462	.009	.471
1962	.465	.015	.480
1963	.470	.015	.485
1964	.469	.015	.484
1965(E)*	.469	.015	.484
1966(E)	.469	.015	.484
1967(E)	.469	.015	.484

*(E) = a forecast estimate

As pointed out in the text, the use of RPC1 overstates total accruals by assuming that firms with taxable profits in excess of the low-rate maximum (LRM) pay the high rate on all their profits. This overestimate would be equal to

$$D3 = (HR - LR)(LRM)(NHRF)$$

That is, RPC1 would overestimate by an amount equal to the difference between the low rate actually applied to the low-rate portion of a high-rate firm's profits (LR) and the rate we apply to it (HR), times the allowable profit per firm that is taxable at the low rate (LRM), times the number of firms that pay tax at both

rates (NHRF). This amount (D3) is added to the dependent variable (TCA) to offset the bias in RPC1. Values for D3 are given below. It is assumed that the annual value is spread evenly over the four quarters of the year.

APPROXIMATE OVERESTIMATE OF TCA DUE TO USE OF RPC1 (D3)
(Millions of dollars)

1952	37.2	1960	77.3
1953	49.8	1961	74.9
1954	48.1	1962	81.7
1955	41.5	1963	97.6
1956	46.5	1964	101.8
1957	45.3	1965(E)*	106.6
1958	61.3	1966(E)	111.7
1959	81.1	1967(E)	116.7

*(E) = a forecast estimate

B. Weighted Average (Federal and Provincial) Corporation Tax Rate (RPC2)

To avoid having to use D3 in the accrual equation we created a weighted average high rate (WHR) applicable to firms that pay at the high rate (HR) on some portion of their profits. We have

$$WHR = \frac{LR\ (LRM)(NHRF) + HR\ [PCTH - (LRM)(NHRF)]}{PCTH}$$

where all symbols have been previously explained. Given WHR we proceed as before, with

$$RPC2U = \frac{WHR\ (PCTH) + LR\ (PCTL)}{PCT}$$

and RPC2 = RPC2U + WPE.

Data values for RPC2U, RPC2 and WPE are shown below. The annual value is assumed to hold in each quarter.

WEIGHTED AVERAGE CORPORATION INCOME TAX RATES

	RPC2U	WPE	RPC2
1952	.500	.015	.515
1953	.456	.015	.471
1954	.451	.016	.467
1955	.436	.016	.452
1956	.433	.016	.449
1957	.429	.009	.438
1958	.421	.009	.430
1959	.448	.009	.457
1960	.447	.009	.456
1961	.439	.009	.448
1962	.442	.015	.457
1963	.444	.015	.459
1964	.444	.015	.459
1965(E)*	.444	.015	.459
1966(E)	.444	.015	.459
1967(E)	.444	.015	.459

*(E) = a forecast estimate

C. Weighted Marginal and Average Federal Corporation Income Tax Rates (FRPC1 and FRPC2)

These may be derived from RPC1, RPC2, and PCTR, the weighted average provincial corporation income tax rate explained in section 3-1-3-1 of this appendix. We have

$$FRPC1 = RPC1 - PCTR$$

and

$$FRPC2 = RPC2 - PCTR$$

Data values are presented below. Once again the annual value is assumed to hold in each quarter.

WEIGHTED FEDERAL CORPORATION INCOME TAX RATES

	FRPC1	FRPC2
1952	.515	.500
1953	.476	.456
1954	.472	.451
1955	.451	.436
1956	.448	.433
1957	.403	.388
1958	.403	.380
1959	.432	.407
1960	.431	.406
1961	.421	.398
1962	.372	.349
1963	.377	.351
1964	.376	.351
1965(E)*	.376	.351
1966(E)	.376	.351
1967(E)	.369	.344

*(E) = a forecast estimate

2-1-4-2 MANUFACTURERS' SALES TAX

The manufacturers' sales tax equation utilizes three tax rates: the basic sales tax rate applicable to durable and nondurable consumption expenditure (RSC), the tax rate applicable to machinery and equipment (RSIM), and the tax rate applicable to construction materials and building supplies (RSIR). Values for these rates, adjusted for within-quarter changes, are shown below expressed in decimal form.

BASIC SALES TAX RATE (RSC)

	1Q	2Q	3Q	4Q
1955	.10	.10	.10	.10
1956	.10	.10	.10	.10
1957	.10	.10	.10	.10
1958	.10	.10	.10	.10
1959	.10	.11	.11	.11
1960	.11	.11	.11	.11
1961	.11	.11	.11	.11
1962	.11	.11	.11	.11
1963	.11	.11	.11	.11
1964	.11	.11	.11	.11
1965	.11	.11	.11	.11
1966	.11	.11	.11	.11
1967	.12	.12	.12	.12
1968	.12	.12	.12	.12

SALES TAX RATE ON MACHINERY AND EQUIPMENT (RSIM)

	1Q	2Q	3Q	4Q
1955	-	-	-	-
1956	-	-	-	-
1957	-	-	-	-
1958	-	-	-	-
1959	-	-	-	-
1960	-	-	-	-
1961	-	-	-	-
1962	-	-	-	-
1963	-	.006	.04	.04
1964	.04	.08	.08	.08
1965	.11	.11	.11	.11
1966	.11	.11	.11	.11
1967	.11	.04	-	-
1968	-	-	-	-

SALES TAX RATE ON CONSTRUCTION MATERIALS AND BUILDING SUPPLIES (RSIR)

	1Q	2Q	3Q	4Q
1955	-	-	-	-
1956	-	-	-	-
1957	-	-	-	-
1958	-	-	-	-
1959	-	-	-	-
1960	-	-	-	-
1961	-	-	-	-
1962	-	-	-	-
1963	-	.006	.04	.04
1964	.04	.08	.08	.08
1965	.11	.11	.11	.11
1966	.11	.11	.11	.11
1967	.11	.11	.11	.11
1968	.11	.11	.11	.11

2-2-4 INTEREST ON THE FEDERAL PUBLIC DEBT

In the equation explaining interest on the federal public debt (IFD) we make use of interest liabilities series for direct market securities (DMSL) and Canada Savings Bonds (CSBL). The methods used to construct these variables, as well as the data sources, are indicated in the text. Below, we present the quarterly time series for DMSL and CSBL, calculated from 1955 to 1967.

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INTEREST LIABILITIES FOR DIRECT MARKET SECURITIES (DMSL)
(Millions of dollars)

	1Q	2Q	3Q	4Q
1955	309.45	309.45	309.95	309.95
1956	308.55	307.65	291.55	298.76
1957	295.45	294.33	292.07	299.64
1958	303.15	313.38	334.65	383.40
1959	392.51	390.21	389.17	396.04
1960	391.34	410.24	412.96	406.63
1961	406.37	416.91	416.01	426.34
1962	426.69	421.89	425.63	437.67
1963	444.92	458.77	460.37	471.94
1964	474.09	475.19	479.72	487.43
1965	478.90	478.62	488.65	483.15
1966	488.77	492.99	495.11	508.89
1967	521.11	536.64	545.91	544.76

INTEREST LIABILITIES FOR CANADA SAVINGS BONDS (CSBL)
(Millions of dollars)

	1Q	2Q	3Q	4Q
1955	.34	.60	.86	65.44
1956	.75	1.31	1.88	73.22
1957	1.17	2.04	2.92	73.47
1958	.59	1.03	1.48	80.49
1959	1.22	2.13	3.05	88.47
1960	34.44	33.99	33.54	33.41
1961	37.40	36.96	36.52	37.81
1962	43.60	42.48	41.36	42.40
1963	52.54	51.95	51.36	52.04
1964	58.64	58.10	57.56	58.23
1965	64.23	63.56	62.89	63.84
1966	68.73	66.39	64.05	61.96
1967	74.00	72.54	71.08	70.13

3-1-1-1 PERSONAL INCOME TAXES

A. Weighted Average Basic Tax Rates (BRW_i)

These rates are analogous to the RW_i of section 2-1-1-1 in all respects except that basic tax payable is substituted for total tax payable in our calculations. Thus

$$BRW_{it} = \sum_{j=1}^{n} [(BT_{jit}/\overline{YT}_{jit})(YAST_{jit}/YAST_{it})] \quad (i=1,2,3,4)$$

where BT_{jit} is the basic tax payable on mean taxable income in group j, class i, year t calculated by using the actual rate schedule applicable in year t. All other variables and subscripts have been previously discussed.[69] Values for BRW_i expressed in decimal form are given below. The annual value is assumed to hold in each quarter.

WEIGHTED AVERAGE BASIC TAX RATES

	BRW1	BRW2	BRW3	BRW4	Overall Weighted Average
1962	.110	.124	.151	.278	.154
1963	.112	.125	.152	.275	.156
1964	.112	.126	.153	.277	.160
1965	.112	.127	.154	.276	.163
1966	.112	.128	.156	.271	.167

B. Total Provincial Effective Rates (TPER1 and TPER2)

TPER1 is the total provincial effective rate for all provinces except Quebec. It is calculated by weighting abatements and provincial surtaxes by the proportion of total tax payable originating in each province. The rates are given in Table 13 on page 122 and the weights are derived from Table 1 of *Taxation Statistics, Part One (Individuals)*. But since Quebec collects its own tax, only that portion of Quebec residents' tax liabilities that is payable to the federal government is shown in Table 1. Thus, before we calculate the weights, we must inflate this number by

$$100/[100 - ARQ]$$

where ARQ is the abatement to Quebec. TPER2 is the total provincial effective rate for Quebec. It is calculated in the same way as TPER1. Values for TPER1 and TPER2 are given below. Once again the annual value is assumed to hold in each quarter.

[69]See this appendix, section 2-1-1-1, pp. 142-144.

TOTAL PROVINCIAL EFFECTIVE RATES,
QUEBEC (TPER2) AND ALL OTHER PROVINCES (TPER1)

	TPER1	TPER2
1962	.126	.039
1963	.133	.042
1964	.140	.045
1965	.159	.116
1966	.181	.123

3-1-1-2 MOTOR VEHICLE LICENCES AND PERMITS, PERSONS
3-1-4-4 MOTOR VEHICLE LICENCES AND PERMITS, BUSINESSES

The data we used to calculate the weighted average rate of licence fee per registered motor vehicle (MVPR) were taken from *The Motor Vehicle, Parts II, III and IV.*[70] The appropriate revenue series for each province was divided by the total number of motor vehicles registered in that province to get a provincial average rate. These rates were weighted by the proportion of total net (i.e. taxable) gasoline sales in each province and the weighted rates were summed over the ten provinces to get MVPR. Values of MVPR from 1950 to 1967 are presented in the following table. The annual rate is assumed to hold in each quarter.

WEIGHTED AVERAGE RATE OF LICENCE FEE (MVPR)
(Dollars per registered motor vehicle)

1950	25.3	1959	30.6
1951	24.9	1960	31.0
1952	24.7	1961	31.2
1953	24.3	1962	30.9
1954	24.7	1963	32.6
1955	28.2	1964	32.9
1956	28.2	1965	34.4
1957	29.1	1966	34.0
1958	29.1	1967	34.5

[70] *The Motor Vehicle, Part II Motive Fuel Sales, The Motor Vehicle, Part III Registrations* and *The Motor Vehicle, Part IV Revenues* issued by D.B.S., catalogue nos. 53-218, 53-219 and 53-220, respectively.

3-1-1-3 HOSPITAL INSURANCE PREMIUMS

To calculate the weighted average hospital insurance premium rate (RWH) we initially obtained a weighted average rate for each of the three provinces concerned (Ontario, Manitoba and Saskatchewan). This calculation was made by weighting the family rate in each province by the proportion of married males in the provincial labour force and weighting the single rate by the proportion of single persons in the provincial labour force. The relevant rates are available from *Principal Taxes and Rates; Federal, Provincial and Selected Municipal Governments.*[71] Appropriate proportions for each province were obtained from 1961 census data[72] and assumed to be constant over the period.

The weighted rate for each province was then weighted by that province's share of the total labour force, available from the *Canadian Statistical Review,*[73] Table 20. Summing the results across the provinces yielded the following series:

WEIGHTED AVERAGE HOSPITAL INSURANCE PREMIUM RATE (RWH)
(Dollars per member of the labour force)

	1Q	2Q	3Q	4Q
1959	3.94	3.92	3.92	3.94
1960	3.98	3.96	3.92	3.94
1961	4.26	4.24	4.01	4.03
1962	4.03	4.02	4.00	4.01
1963	4.03	4.03	4.00	4.03
1964	3.97	3.97	5.71	5.72
1965	5.79	5.75	5.74	5.74
1966	5.77	5.77	5.74	5.75
1967	5.80	5.81	5.78	5.77
1968	5.82	9.26	9.23	9.28

[71]*Principal Taxes and Rates; Federal, Provincial and Selected Municipal Governments* issued by D.B.S., catalogue no. 68-201.

[72]*The Canadian Labour Force* special series issued by D.B.S., catalogue no. 99-522.

[73]*Canadian Statistical Review* issued monthly by D.B.S., catalogue no. 11-003.

3-1-3-1 CORPORATION INCOME TAX ACCRUALS

A. Weighted Average Provincial Corporation Tax Rate (PCTR)

PCTR is equal to the weighted average federal abatement to the provinces (WAAR) plus the weighted average of any additional levies imposed by provincial governments (WPE). The relevant rates are set out in the text and these were weighted by the share of taxable corporation profits in each province, obtained from *Taxation Statistics, Part Two (Corporations)*. The relevant rates, expressed as decimals, are:

WEIGHTED AVERAGE PROVINCIAL CORPORATION INCOME TAX RATES

	WAAR	WPE	PCTR
1952	-	.015	.015
1953	-	.015	.015
1954	-	.016	.016
1955	-	.016	.016
1956	-	.016	.016
1957	.041	.009	.050
1958	.041	.009	.050
1959	.041	.009	.050
1960	.041	.009	.050
1961	.041	.009	.050
1962	.093	.015	.108
1963	.093	.015	.108
1964	.093	.015	.108
1965(E)*	.093	.015	.108
1966(E)	.093	.015	.108
1967(E)	.100	.015	.115

*(E) = a forecast estimate

Provincial corporate accruals generated as described in the text (PCA) are shown below.

PROVINCIAL CORPORATION INCOME TAX ACCRUALS (PCA)
(Millions of dollars)

	1Q	2Q	3Q	4Q
1952	9	10	10	10
1953	9	11	10	9
1954	8	10	10	10
1955	9	12	13	12
1956	11	14	14	13
1957	35	43	40	36
1958	33	40	41	42
1959	37	47	45	45
1960	39	45	44	41
1961	34	46	47	47
1962	87	110	106	108
1963	93	120	113	118
1964	106	134	125	135
1965	114	143	136	142
1966	121	146	127	140
1967	119	149	141	151

As explained in the text (section 2-1-2, part B), if this series is used for PCA the corresponding federal accrual series is FCAR, given below.

FEDERAL CORPORATION INCOME TAX ACCRUALS (FCAR)
(Millions of dollars)

	1Q	2Q	3Q	4Q
1952	288	368	361	328
1953	280	342	307	252
1954	228	278	279	259
1955	226	327	350	323
1956	280	376	371	334
1957	283	339	307	254
1958	241	298	325	295
1959	286	390	369	362
1960	310	380	357	328
1961	268	376	395	399
1962	275	346	335	343
1963	294	370	347	372
1964	333	417	392	411
1965	346	452	426	466
1966	342	480	432	465
1967	322	455	414	457

3-1-4-2 GASOLINE TAXES

A. Weighted Average Gasoline Tax Rate (RWG)

Gasoline tax rates are also obtained from *Principal Taxes and Rates; Federal, Provincial and Selected Municipal Governments.* These rates were weighted by the proportion of taxable gasoline sales in each province, available on a monthly basis in *The Motor Vehicle, Part II Motive Fuel Sales.* Summing across the provinces we obtained the following series:

WEIGHTED AVERAGE GASOLINE TAX RATE (RWG)
(Dollars per gallon)

	1Q	2Q	3Q	4Q
1959	.125	.125	.126	.126
1960	.125	.126	.126	.126
1961	.127	.133	.134	.134
1962	.134	.134	.134	.134
1963	.134	.139	.139	.139
1964	.143	.147	.147	.147
1965	.147	.151	.151	.151
1966	.151	.156	.155	.155
1967	.155	.155	.156	.156

B. Weighted Average Diesel Oil Tax Rate (RWD)

The calculation of this rate involved weighting each province's diesel oil tax rate by that province's share in net (i.e. taxable) diesel oil sales, and summing across the ten provinces. Sources used for the rates and weights were the same as those used to obtain the corresponding data for RWG. Statistics on sales of taxable diesel oil by province are available monthly only from 1962 on, and no figures are available for Nova Scotia prior to 1964. In order to obtain the data needed we first estimated an annual total for Nova Scotia for each year from 1959 to 1963, assuming that Nova Scotia's annual share of total diesel oil sales in each of those years was equal to its share in aggregate sales in 1964 and 1965 (that is, 1.4 per cent). The 1959-1961 annual totals for each province were then spread quarterly according to the 1962 quarterly distribution. The resulting RWD series is given below.

WEIGHTED AVERAGE DIESEL OIL TAX RATE (RWD)
(Dollars per gallon)

	1Q	2Q	3Q	4Q
1959	.141	.148	.142	.142
1960	.139	.145	.141	.141
1961	.139	.163	.155	.154
1962	.178	.178	.180	.180
1963	.180	.189	.189	.187
1964	.190	.194	.194	.195
1965	.195	.200	.201	.199
1966	.198	.204	.203	.201
1967	.201	.202	.203	.203

3-1-4-7 RETAIL SALES TAXES

The weighted sales tax rate (RWS) was obtained by weighting the provincial rates by each province's proportion of monthly retail trade. The value of total retail trade by province is available monthly in the *Canadian Statistical Review*, Table 85. Since tax receipts are received and recorded by the provinces with a lag of one month (one quarter in the case of Saskatchewan), the monthly retail trade figures used in the weighting have been lagged accordingly. The following series was calculated by using this procedure.

WEIGHTED AVERAGE RETAIL SALES TAX RATE (RWS)
(Percentages)

	1Q	2Q	3Q	4Q
1952	1.124	1.091	1.136	1.130
1953	1.129	1.093	1.144	1.138
1954	1.131	1.171	1.328	1.317
1955	1.308	1.269	1.313	1.311
1956	1.327	1.296	1.336	1.325
1957	1.337	1.315	1.332	1.318
1958	1.325	1.296	1.313	1.307
1959	1.415	1.397	1.425	1.409
1960	1.416	1.391	1.467	1.457
1961	1.463	1.458	2.399	3.189
1962	3.304	3.267	3.292	3.279
1963	3.302	3.284	3.308	3.294
1964	3.317	3.676	3.835	3.848
1965	3.835	3.810	3.798	3.803
1966	3.777	4.555	4.551	4.543
1967	4.606	5.238	5.403	5.402
1968	5.350	5.465	5.413	5.407

INDEX TO THE GOVERNMENT SECTOR OF THE CANADIAN ECONOMY

The first section of this index is reserved for quantitative forecasts, while in subsequent sections reference is made to the analytic framework and fitted equations from which the forecasts are derived.

Each item in the index is preceded by a code number. From section 2 on, the first digit in each code number refers to the level of government. Thus 2 refers to the federal government and 3 to the provinces and municipalities. The second digit indicates the nature of the item: 1 refers to a revenue item, 2 to an expenditure item or a transfer payment, and 3 to a change in an asset or liability account. The next digits indicate subclassifications.

[74]These will be disaggregated by department and by type of expenditure.

[75]The federal government announced on August 30, 1968 that no incentives would be provided for winter works projects in the winter of 1968-1969.

[76]On October 1, 1969 ECIC was succeeded by the Export Development Corporation which has wider powers than ECIC had and greater financial resources.

[77]On November 10, 1969 Banque Populaire, formerly Banque d'Économie de Québec (a Quebec savings bank), commenced operations as a chartered bank. Thus The Montreal City and District Savings Bank is now the only Quebec savings bank still in existence.

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3-2-3-8 Miscellaneous transfers (including industrial employees vacations benefits)

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3-3-3-2-3 Chartered bank loans outstanding
3-3-3-2-4 Municipal debt held by municipal accounts

3-3-4 Net changes in cash balances—provincial and municipal (3-3-1 minus 3-3-2 plus 3-3-3)

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*References to official publications appear in the footnotes throughout the paper.

No. 5

BANK OF CANADA
STAFF RESEARCH STUDIES

THE DYNAMICS OF RDX1

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1969

ISSUED BY THE PUBLICATIONS COMMITTEE OF THE BANK OF CANADA

THE DYNAMICS OF RDX1

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Lawrence H. Officer

Harold T. Shapiro

Ian A. Stewart

This study was prepared as part of the econometric research program of the Research Department of the Bank of Canada. The views expressed are the personal views of the authors and no responsibility for them should be attributed to the Bank.

PREFACE

This study contains an examination of the dynamic properties of the macroeconomic model presented in Staff Research Study No. 3, *The Structure of RDX1*. We have described elsewhere [4] some of the results of our simulation experiments. Here a fuller description is given of all our policy simulations, supplemented by some experiments that attempt to see which parts of the model's structure are responsible for certain of its important simulation properties.

In order to make this study as self-contained as possible, we have reproduced the appendices of *The Structure of RDX1*. These appendices contain the equation titles grouped by sector, a full alphabetical listing of the structural equations along with ordinary least squares and consistent parameter estimates, and a list defining all the endogenous and exogenous variables in the model. We have added a flow chart (Chart 10) of the causal influences in RDX1, and a schematic version of this chart (Chart 9). These charts are discussed in a new appendix (Appendix D).

As was the case with *The Structure of RDX1* the following colleagues were associated with the testing and simulations recorded here: Robert Evans, Fred Gorbet, Claude Huot, Jules Hurtubise, Peter Miles, Diane Nymark, Lynne Orman, Lawrence Smith, and Donald Stephenson. To this list we wish to add André Lemelin, who is responsible for the flow chart mentioned above.

The further experiments we have conducted since the first publication of RDX1 have given us ample justification for the modesty of our initial statements about the model, and lots of ideas for improvements to be built into RDX2. Though the dynamics

of RDX1 may not be exactly, or even approximately, those of the Canadian economy, the dynamic simulations using RDX1 have made a valuable contribution to our search for improved descriptions of how the economy works.

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PRÉFACE

L'étude ci-après contient une analyse des propriétés dynamiques du modèle macroéconomique qui a fait l'objet de l'étude N° 3—intitulée *The Structure of RDX1*—dans la série des Travaux de recherche à la Banque. Nous avons exposé ailleurs [4] quelques résultats de nos expériences de simulation. Nous donnons ici une description plus complète de toutes les simulations de politiques auxquelles nous avons procédé, en y ajoutant certaines expériences dont l'objet était de déterminer les éléments du modèle qui expliquent certaines de ses importantes propriétés de simulation.

Afin que cette étude forme un tout aussi complet que possible, nous y avons ajouté les annexes de l'étude *The Structure of RDX1*. Elles contiennent les titres des équations groupés par secteur, une liste alphabétique complète des équations structurelles, y compris les estimations par la méthode des moindres carrés et des variables instrumentales, et une liste de définitions portant sur toutes les variables endogènes et exogènes du modèle. Nous avons ajouté un diagramme des flux, le Graphique 10, indiquant les rapports de causalité dans RDX1, ainsi qu'une version schématique du diagramme, le Graphique 9. On trouvera une explication de ces deux graphiques dans une nouvelle annexe, l'Annexe D.

Comme pour l'étude *The Structure of RDX1*, MM. Robert Evans, Fred Gorbet, Claude Huot, Jules Hurtubise, Peter Miles, Mlles Diane Nymark et Lynne Orman, MM. Lawrence Smith et Donald Stephenson ont pris part aux simulations et aux tests relatés dans cette étude. Nous tenons à mentionner également M. André Lemelin, à qui nous devons le diagramme des flux susmentionné.

Les expériences que nous avons menées depuis la première publication du RDX1, nous ont démontré que nous avions eu raison d'être plutôt modestes lors du nos premières présentations du modèle et nous ont suggéré plusieurs idées concernant les améliorations susceptibles d'être incorporées dans le modèle RDX2. Bien que le comportement dynamique du modèle RDX1 ne corresponde pas exactement, ni même approximativement, à celui de l'économie canadienne, ses simulations dynamiques nous ont considérablement aidés dans nos recherches de meilleures descriptions du fonctionnement réel de l'économie.

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THE DYNAMICS OF RDX1

1. Introduction

A model as non-linear as RDX1 offers a wide range of possibilities for simulation experiments. In the specification of RDX1, non-linearities arise in a number of places where rates of utilization of the capital stock (Y/YC) and of the labour force (NU/NL) affect aggregate demand, the balance of trade, wages, and prices. Further, prices and wages themselves have various impacts on aggregate demand, average hours worked, and so on. We started out with the expectation, therefore, that RDX1 would behave rather differently in two important respects from the largely demand-determined models more commonly used for policy analysis. First, supply considerations play an important role. Second, the model contains important non-linearities. Thus the values of our dynamic policy multipliers depend as usual on the passage of time and are related in an important way to:

(a) Initial conditions, in particular, the rates of utilization of the capital stock and the labour force.

(b) Particular features of the policy change. For example, changes in government wage payments (GW), nonwage expenditure (GNW), and transfer payments (GTR) all have different multipliers for all succeeding periods, and also show different time patterns of response.

(c) Values given to the exogenous variables.

In the face of these complexities, experimental design requires a mix of courage and ingenuity. One is tempted to suspect that the reason so many models are linearized for simulation purposes is not only to make computations easier but also to reduce the bewildering range of potential experiments. The set of experiments reported here is but a small subset of possible experiments and we recognize that our priorities may not be shared by others.

The present paper presents the results and analysis of an extensive series of simulations designed to reveal the essential dynamic properties of RDX1. Section 6 of the paper contains a range of somewhat different simulation experiments intended to test the sensitivity of these dynamic properties to changes in certain aspects of RDX1. Particular attention is paid to the sensitivity of the 'import leakage' and to the effects of price changes. In an open economy, such as that of Canada, these aspects of the model are of special significance.

2. Long-Period Simulations and Forecasting Results

Our first runs of RDX1 were intended to find out how well the model as a whole could predict the endogenous variables within and outside the sample period. After first running a forty-quarter simulation, starting in 1Q58, we divided most of our simulations into two main blocks of sixteen quarters each. The first block, from 1Q58 to 4Q61, is characterized by low levels of output and employment in relation to capacity. The second block, from 1Q64 to 1Q67, covers a period of rising capacity utilization and upward pressures on prices and wages. In addition, the latter half of this period lies outside the sample period, which ended in 4Q65. The purpose of these experiments is to discover any severe defects of the model that could make it tend to deviate drastically from the path of the economy. The sixteen-quarter and eight-quarter simulations provide comparisons of the forty-quarter run with experiments that re-initialize the lagged endogenous variables to their true values at certain points (4Q63, 4Q65) during the sample period.

Our prediction runs (control solutions) for all these periods showed that the dynamic characteristics of the model keep the main endogenous variables close to their actual values during times of radically different economic conditions. Our forty-quarter simulation showed that the model performed well even ten years later. Charts 1, 2 and 3 show the actual and predicted values of some of the principal endogenous variables in the forty-quarter, sixteen-quarter, and eight-quarter simulations. These charts also reveal that the model traces the actual path of the economy remarkably well from 1958 to 1967. This is true not only

for gross output and expenditure but also for their component aggregates, although of course there are some problems in detail. The predictive ability of the model, however, does deteriorate somewhat outside the sample period (see Charts 2 and 3). Although the errors are small, they tend at times (e.g., in the period 1Q62-1Q65) to exhibit autoregressive patterns. The chief cause of the autoregressive errors in the early 1960's was a string of autoregressive errors in the export equations. When these errors ended, the model came fairly quickly back on track. Thus over a dynamic simulation as long as forty quarters there is no tendency for the model to explode. Re-initialization of the lagged endogenous variables to their actual values at 4Q63 (Chart 2) and 4Q65 (Chart 3) produces only marginal and temporary improvements in the model's predictive power.

A major forecasting weakness of RDX1 is its failure to generate satisfactory predictions of the unemployment rate (NU/NL). Unemployment is determined residually from an identity in which the labour force and most of the components of total employment have stochastic explanations. Small predictive errors in any of these components lead to relatively large percentage errors in the unemployment rate. Our experiments indicate, however, that the present version of RDX does provide a suitable framework for analyzing the employment effects of alternative economic policies.

The typical error in predicting the short-term interest rate (R03) is about 30 basis points. Furthermore, the model correctly predicts turning points in R03 about two-thirds of the time. The rest of the time forecasted changes lag the actual changes by one quarter. On the whole, interest rate predictions are substantially better in the latter half of the sample period.

As a further initial check on the properties of the system we re-initialized the model at 4Q65 and put it to work outside the sample period. Chart 3 illustrates the forecasting performance for 1966 and 1967 under these conditions. However, because we use the actual values of exogenous variables, this is not an adequate test of the model's ability to act as a forecasting tool. As noted above, the forecast errors for 1966 and 1967 are larger than those encountered over the sample period. The performance of the foreign sector deserves special comment. Underestimation of both imports and exports reflects the role of the Canada-

Chart 1

FORTY-QUARTER SIMULATION 1958-1967 Millions

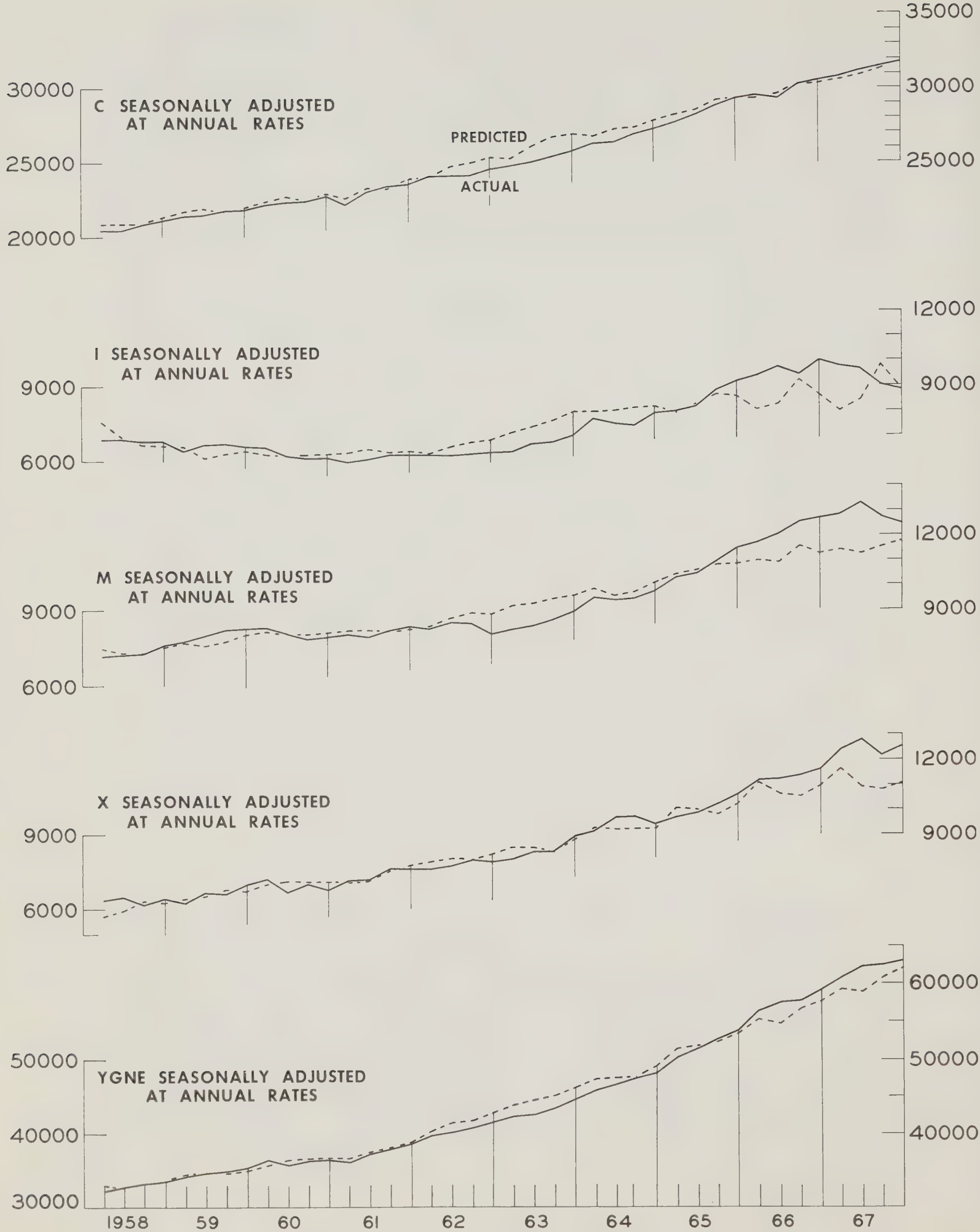


Chart 1 (cont'd)

FORTY-QUARTER SIMULATION
1958-1967

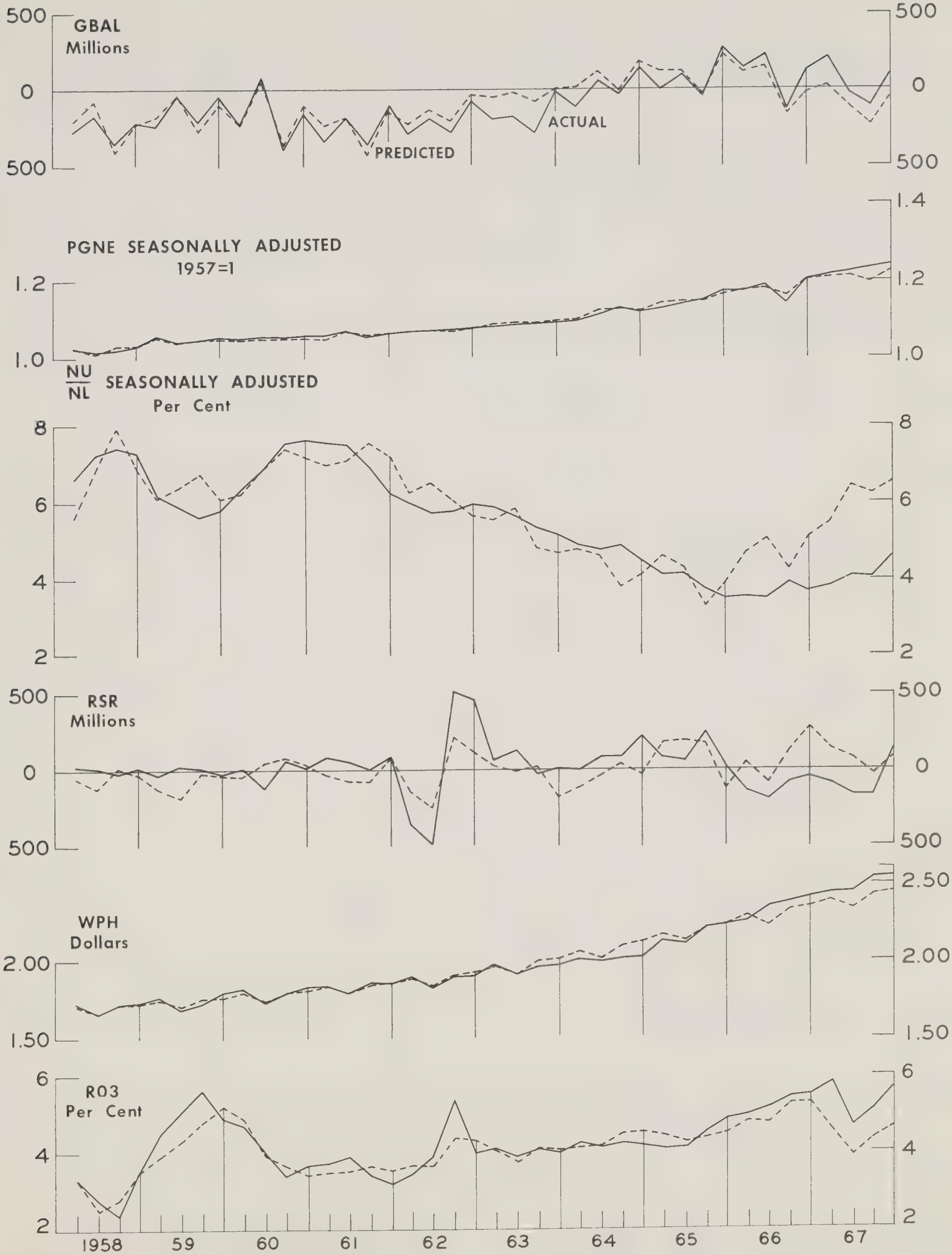


Chart 2

SIXTEEN-QUARTER SIMULATION
1964-1967

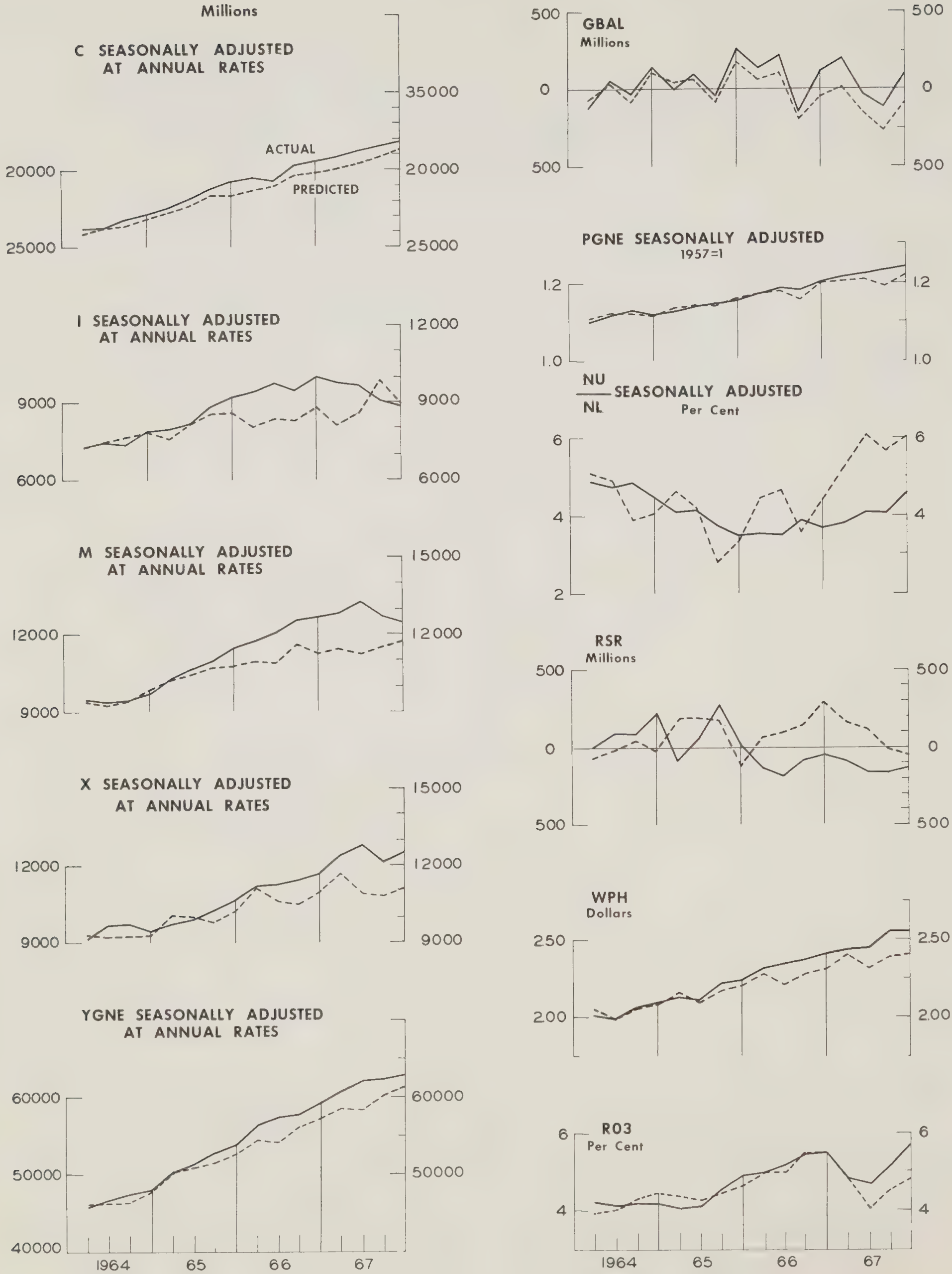
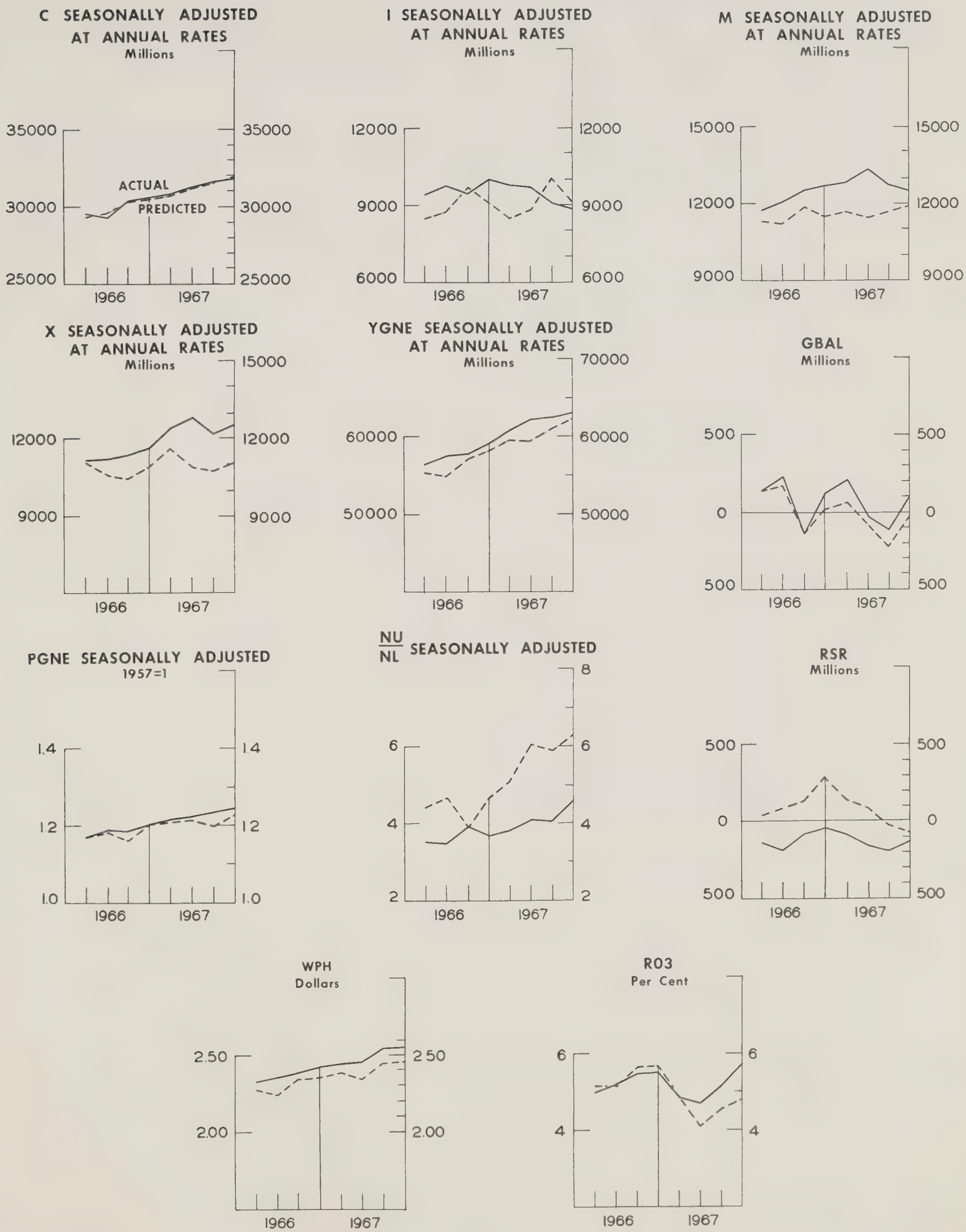


Chart 3

EIGHT-QUARTER SIMULATION 1966-1967



United States Agreement on Automotive Products in expanding trade, while overestimation of the accumulation of reserves is probably due to the inability of any model estimated with 1953-1965 data to recognize automatically the tightening of U.S. balance of payments guidelines that took place in 1966 and 1967.

To give us some better idea of the longer-run dynamic response of our system, we shocked the model by permanently increasing the level of bond-financed government expenditure by \$100 million (GNW + 75, GW + 25) beginning in 1Q58 (with no change in tax rates or in the monetary base (BCD)), and compared the time paths of the endogenous variables with the time paths obtained from the forty-quarter control solution. The response of constant-dollar expenditure $\left(\left(YGPK + \frac{GW + GNW}{PGNE}\right)\right.$, labelled as Y/P in all tables and referred to in the text as constant-dollar expenditure) to this stimulus reaches a peak of \$177 million in the twelfth quarter following the initial shock. This increase in expenditure then declines and follows a cyclical pattern that generates an increase in real expenditure of \$133 million by the end of the fortieth quarter. Price increases reach an initial peak of about six-tenths of 1 per cent six quarters after the shock is imposed. Thereafter prices slowly diverge from the control solution in a cyclical fashion. By the end of the twelfth and fortieth quarters we have price increases of one-fifth and two-thirds of 1 per cent, respectively. The current-dollar expenditure (YGNE) multiplier reaches an initial peak of 2.1 about eight quarters out, then follows a cyclical pattern around a mean value of approximately 2.0. It is also interesting to note that the government accounts balance (GBAL) shows a tax recovery of about one-half the expenditure increase.

Short-term interest rates (R03) respond as expected (given the lags in the monetary adjustment process), rising to a maximum differential over control eight to nine quarters out, then declining to a level about 20 basis points above the control solution. The response of private employment to the fiscal measure is felt first in average weekly hours worked (HAW) and only afterwards in the number of employed workers in the private sector (NEPP). The hours-employment cycle in the private sector induces a corresponding cycle in the unemployment rate. Interestingly enough, however,

the induced rise in private hourly wage rates (WPH) maintains itself throughout the period.

Our next step was to investigate the sensitivity of the dynamic policy responses of the system to overall levels of capacity utilization. For this purpose we ran two basic sets of simulation experiments, one from 1958 to 1961 (low capacity utilization) and the other from 1964 to 1967 (high capacity utilization). Some of the results are presented in Tables 1 and 2. Three types of experiments were performed:

(1) An 'equivalent' increase in government nonwage expenditure in the two periods. 'Equivalent' injections were obtained by setting the size of the stimulus at the same percentage of full-capacity YGNE, (YGNE(YC/Y)), in the two periods. The absolute increase was $100 million in 1958, and $130 million in 1964.

(2) A 100 basis-point decrease in Canadian short-term interest rates (R03).

(3) A combination of a 100 basis-point reduction in Canadian short-term rates (R03), accompanied by a policy of lower interest rates in the United States. The latter is taken as a 100 basis-point reduction in the U.S. short-term rate with the U.S. long-term rate adjusted by a term structure relation.[1] In this experiment we compute the induced changes in absolute form and as a percentage of the control solution. This calculation is done to highlight the differences between the results in the two periods.

Comparing the fiscal experiments in the two periods, we see that, qualitatively, the results are as expected; in the period

[1]The term structure relationship needed to obtain the movement in the long-term rate (RLUS) was estimated by ordinary least squares for the period 2Q52-4Q67 and is:

$$RLUS = .165 + .108\ RTUS + .900\ RLUS$$

TABLE 1

SIXTEEN-QUARTER SIMULATION RESULTS (1Q58-4Q61) FOR SELECTED VARIABLES
(Shocked-Control)

	Units	1Q58	2Q58	3Q58	4Q58	1Q59	2Q59	3Q59	4Q59	1Q60	2Q60	3Q60	4Q60	1Q61	2Q61	3Q61	4Q61
YGNE	Millions of current dollars																
Fiscal		108	133	145	168	171	187	190	208	191	202	201	213	191	209	210	213
Monetary		4	10	14	21	27	34	41	50	54	61	67	77	73	79	80	87
Monetary + U.S.		4	10	15	24	34	46	58	73	83	98	111	132	132	147	156	176
% of Control		.054	.13	.16	.28	.44	.54	.60	.83	1.02	1.10	1.10	1.43	1.57	1.59	1.53	1.79
Y/P	Millions of 1957 dollars																
Fiscal		96	108	105	117	121	135	137	160	152	164	163	177	160	169	167	174
Monetary		4	11	16	24	30	38	45	55	58	65	69	77	73	76	75	78
Monetary + U.S.		4	12	17	27	38	50	63	80	90	105	117	135	135	146	151	165
% of Control		.05	.16	.21	.31	.50	.62	.74	.91	1.14	1.26	1.32	1.48	1.68	1.68	1.65	1.72
CD + CND + CS	Millions of 1957 dollars																
Fiscal		17	28	35	49	50	60	62	81	71	69	77	95	82	90	88	105
Monetary		1	2	4	11	6	22	25	33	34	39	41	50	47	51	52	59
Monetary + U.S.		1	2	4	13	20	29	36	48	52	63	70	86	85	96	100	118
% of Control		.02	.04	.08	.22	.39	.53	.67	.81	.99	1.11	1.27	1.40	1.57	1.65	1.77	1.84
IME + INRC + IRC	Millions of 1957 dollars																
Fiscal		7	11	18	36	43	52	56	68	65	66	63	65	61	56	53	51
Monetary		6	12	16	20	23	27	32	40	43	47	49	54	53	50	47	47
Monetary + U.S.		6	12	17	23	28	36	44	58	66	75	81	93	97	97	97	104
% of Control		.39	.65	.92	1.37	2.14	2.17	2.55	3.58	5.15	4.55	4.71	5.82	7.64	5.74	5.53	6.35
MG + MS/PMS	Millions of 1957 dollars																
Fiscal		26	39	47	62	60	66	67	73	64	66	64	66	54	56	57	57
Monetary		2	5	6	10	12	12	19	23	23	26	27	30	27	28	27	27
Monetary + U.S.		2	5	7	11	15	20	27	34	36	43	47	54	51	55	56	61
% of Control		.12	.26	.38	.58	.87	.98	1.38	1.67	1.95	2.02	2.31	2.60	2.73	2.54	2.78	2.87

XG + XS/PXS	Millions of 1957 dollars																
Fiscal		-11	-13	-15	-17	-15	-17	-18	-17	-14	-13	-14	-13	-11	-10	-11	-10
Monetary		0	-1	-1	-2	-2	-3	-3	-3	-3	-3	-3	-4	-3	-2	-3	-2
Monetary + U.S.		0	-1	-1	-3	-2	-4	-4	-5	-5	-5	-6	-7	-6	-5	-6	-6
% of Control		0	-.066	-.059	-.18	-.15	-.24	-.22	-.29	-.32	-.28	-.31	-.38	-.39	-.27	-.30	-.30
GBAL	Millions of current dollars																
Fiscal		-70	-69	-67	-58	-57	-51	-56	-49	-49	-44	-52	-48	-50	-44	-52	-48
Monetary		1.0	3.0	3.0	5.0	7.0	11.0	11.0	15.0	16.0	20.0	18.0	22.0	22.0	24.0	21.0	23.0
Monetary + U.S.		1.0	3.0	3.0	7.0	9.0	14.7	15.0	21.0	26.0	31.2	30.0	37.0	41.0	45.0	42.0	47.0
NU/NL	Percentage points																
Fiscal		-.19	-.30	-.37	-.42	-.44	-.50	-.49	-.53	-.53	-.54	-.55	-.57	-.54	-.53	-.50	-.80
Monetary		-.01	-.03	-.04	-.07	-.10	-.13	-.16	-.20	-.22	-.24	-.27	-.30	-.30	-.30	-.30	-.30
Monetary + U.S.		-.01	-.03	-.05	-.08	-.12	-.16	-.22	-.28	-.32	-.37	-.44	-.50	-.53	-.56	-.58	-.62
R03	Percentage points (Basis points/100)																
Fiscal		.06	.11	.16	.19	.21	.23	.24	.25	.24	.24	.24	.24	.22	.22	.21	.20
RSR	Millions of current (Canadian) dollars																
Fiscal		-28	-34	-34	-35	-28	-26	-23	-22	-15	-15	-14	-14	-7	-11	-11	-15
Monetary		-63	-78	-89	-97	-102	-106	-109	-111	-110	-112	-113	-114	-112	-113	-113	-112
Monetary + U.S.		-7	-16	-19	-23	-27	-31	-33	-35	-35	-38	-40	-41	-39	-41	-42	-44
WPH	Cents																
Fiscal		.2	.4	.6	1.0	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.3	2.5	2.6	2.8	3.0
Monetary		0	0	0	.1	0	.1	.1	.1	.3	.3	.4	.4	.5	.6	.7	.8
Monetary + U.S.		0	0	0	.1	0	.1	.1	.2	.3	.4	.5	.6	.7	.9	.11	.13
PGNE	1957=1																
Fiscal		.002	.003	.005	.006	.006	.006	.005	.005	.004	.004	.003	.002	.003	.003	.003	.004
Monetary		0	0	0	0	-.001	-.001	-.001	-.001	-.002	-.001	-.001	-.001	-.001	-.001	0	.001
Monetary + U.S.		0	0	0	0	-.001	-.001	-.001	-.001	-.001	-.001	-.001	-.001	-.001	-.001	0	.001

TABLE 2

SIXTEEN-QUARTER SIMULATION RESULTS (1Q64-4Q67) FOR SELECTED VARIABLES
(Shocked-Control)

	Units	1Q64	2Q64	3Q64	4Q64	1Q65	2Q65	3Q65	4Q65	1Q66	2Q66	3Q66	4Q66	1Q67	2Q67	3Q67	4Q67
YGNE	Millions of current dollars																
Fiscal		136	168	196	231	238	264	294	322	284	293	277	289	239	248	251	272
Monetary		4	8	11	19	27	36	50	64	67	76	86	95	86	90	91	97
Monetary + U.S.		4	8	12	23	35	48	71	93	103	123	144	166	159	173	181	200
% of Control		.038	.070	.094	.19	.31	.38	.51	.70	.83	.92	1.11	1.15	1.18	1.19	1.13	1.29
Y/P	Millions of 1957 dollars																
Fiscal		107	118	114	124	127	136	137	156	136	138	135	148	119	124	126	139
Monetary		4	8	10	18	26	32	39	47	49	53	56	62	55	56	56	60
Monetary + U.S.		4	8	11	22	33	43	55	70	77	88	98	115	109	117	122	135
% of Control		.041	.077	.10	.20	.32	.39	.49	.59	.71	.77	.81	.91	.97	.97	.98	1.04
CD + CND + CS	Millions of 1957 dollars																
Fiscal		28	32	41	58	62	74	78	102	91	100	93	110	92	98	91	106
Monetary		0	2	3	10	15	21	25	32	34	41	42	50	48	52	51	56
Monetary + U.S.		0	2	3	11	19	28	36	48	54	66	72	89	88	98	100	116
% of Control		0	.030	.048	.15	.29	.40	.53	.62	.79	.91	1.00	1.11	1.23	1.29	1.35	1.37
IME + INRC + IRC	Millions of 1957 dollars																
Fiscal		6	9	14	31	39	48	49	59	53	52	47	46	37	31	26	24
Monetary		5	8	11	15	20	25	29	35	38	41	42	45	44	42	39	38
Monetary + U.S.		5	9	13	18	25	33	40	51	59	67	72	83	85	85	84	88
% of Control		.080	.13	.63	.87	1.52	1.56	1.80	2.29	3.33	3.03	3.05	3.64	4.75	3.69	3.38	3.78
MG + MS/PMS	Millions of 1957 dollars																
Fiscal		29	43	55	73	72	79	83	91	76	76	72	72	53	53	51	54
Monetary		1	3	5	8	11	15	19	25	24	27	29	32	27	27	25	25
Monetary + U.S.		1	3	5	10	14	20	27	36	38	45	50	58	53	56	56	59
% of Control		.047	.12	.21	.39	.60	.74	1.03	1.29	1.51	1.59	1.76	1.96	2.02	1.89	1.93	1.93

XG + XS/PXS	Millions of 1957 dollars																
Fiscal		-11	-13	-16	-17	-17	-19	-23	-21	-18	-19	-19	-17	-13	-13	-14	-13
Monetary		0	-1	0	-1	-2	-2	-4	-3	-3	-4	-4	-4	-3	-3	-4	-3
Monetary + U.S.		0	-1	0	-2	-2	-3	-5	-5	-5	-6	-7	-8	-7	-7	-8	-7
% of Control		0	-.042	0	-.082	-.09	-.12	-.19	-.19	-.21	-.22	-.25	-.29	-.27	-.25	-.28	-.25
GBAL	Millions of current dollars																
Fiscal		-102	-88	-83	-73	-70	-62	-64	-56	-61	-56	-65	-64	-73	-66	-74	-70
Monetary		1	1	3	6	8	11	13	16	18	22	21	24	24	26	24	25
Monetary + U.S.		1	2	3	7	10	15	18	24	28	35	36	43	46	51	47	52
NU/NL	Percentage points																
Fiscal		-.19	-.30	-.42	-.44	-.40	-.38	-.50	-.44	-.32	-.24	-.21	-.17	-.10	-.06	-.04	-.02
Monetary		-.01	-.02	-.03	-.05	-.07	-.09	-.14	-.16	-.15	-.14	-.17	-.17	-.15	-.13	-.13	-.12
Monetary + U.S.		-.01	-.02	-.03	-.05	-.08	-.11	-.19	-.23	-.23	-.24	-.29	-.31	-.30	-.29	-.30	-.32
R03	Percentage points (Basis points/100)																
Fiscal		.06	.13	.18	.23	.26	.28	.31	.32	.31	.29	.28	.27	.22	.19	.18	.18
RSR	Millions of current (Canadian) dollars																
Fiscal		-35.3	-44.9	-46.7	-53.3	-46.2	-44.8	-45.0	-47.8	-34.7	-34.1	-32.6	-35.4	-20.7	-23.2	-24.3	-31.5
Monetary		-63	-77	-86	-97	-104	-110	-115	-118	-118	-120	-122	-124	-120	-121	-122	-119
Monetary + U.S.		-8	-13	-17	-24	-29	-35	-41	-46	-47	-51	-55	-60	-55	-57	-60	-60
WPH	Cents																
Fiscal		.2	.5	1.1	1.7	2.3	2.7	3.3	4.0	4.5	4.4	4.4	4.5	4.7	4.4	4.4	4.6
Monetary		0	0	.1	.1	.1	.2	.3	.5	.7	.8	.9	1.0	1.2	1.1	1.2	1.2
Monetary + U.S.		0	0	.1	.1	.1	.2	.4	.7	1.0	1.2	1.4	1.6	1.9	1.8	1.9	2.0
PGNE	1957=1																
Fiscal		.002	.003	.006	.008	.009	.010	.012	.012	.012	.011	.010	.009	.008	.008	.008	.008
Monetary		0	0	0	0	0	0	.001	.001	.001	.001	.001	.001	.002	.002	.002	.002
Monetary + U.S.		0	-.001	0	0	0	0	.001	.001	.001	.002	.002	.002	.002	.003	.003	.003

of high capacity utilization (1964-1967) the expansion of real output is lower and the price inflation more severe. In the low-capacity period (1958-1961), for example, the fiscal stimulus produced an increase in constant-dollar expenditure of 1.76 times the initial injection by the sixteenth quarter. Accompanying this growth in output was a decrease of 0.8 percentage points in the unemployment rate. A larger absolute fiscal stimulus (but equivalent as a proportion of full-capacity output) in the high-capacity period (1964-1967), produces, by the sixteenth quarter, an increase in constant-dollar expenditure of only 1.19 times the initial injection. By 4Q67, the unemployment rate is hardly affected at all, while the induced price inflation is almost twice as great in 4Q67 as in 4Q61.

The monetary experiments reveal several notable characteristics. First, as expected, the real expansionary effects of a given decrease in interest rates are much weaker at higher levels of capacity utilization. During the 1964-1967 period the specified policy of monetary ease produced an increase in constant-dollar expenditure, which dropped the unemployment rate by only 0.12 percentage points. By contrast, the same policy of ease in 1958-1961 produced an increase nearly 30 per cent larger in real expenditure and a fall of 0.30 percentage points in the unemployment rate. Once again the inflationary impact is greater in the period of relatively high utilization.

Second, as expected, a policy of monetary ease in the United States strengthens the effect of similar Canadian policy actions. This is simply a reflection of the important constraint that the U.S. capital market places on our system. U.S. monetary ease also offsets the considerable reserve loss (RSR) of a unilateral Canadian policy of monetary ease, the extent of the 'offset' being about one-half. In both periods aggregate demand responds strongly, although with a lag, to the expansionary monetary policy. Finally, we note that in the case of these monetary experiments, which involve no initial expenditure effects, the delay in the response of unemployment is longer than in the fiscal experiment.

Now we are in a position to consider more carefully the possibilities open to economic policy as revealed by our model. First, we shall consider how the model reacts in the short run to internal and external shocks, assuming no change in government

policies. This will give us some idea of the strength that policies must have if they are to stabilize or improve conditions brought about by shocks to the system. With this information in hand, we can calculate the impact on our model of a number of individual monetary and fiscal policies. Then we can go on to consider the effects of choosing various 'policy mixes' (i.e., particular values for a selected pair of monetary and fiscal instruments).

3. Short-Term Effects of Changes in Domestic and Foreign Activity

To set the stage for a discussion of the effectiveness of various instruments of economic policy on the model, we first consider the domestic effects of shocks that stabilization policies might be intended to offset. The first part of Table 3 shows the effects, after six quarters:[2] of changes in foreign output and prices (as our first example),of an exogenous increase in domestic expenditure on consumer durables, and, finally, of an increase in expenditure on machinery and equipment. In all three cases we have assessed the effects of such shocks during both the low capacity utilization period and the high capacity utilization period.

To represent the impact of a fairly widespread recession in other countries, we lowered the world activity index (AWI) by 5 per cent of its actual value, and accompanied this with a 1 per cent reduction in the price of world exports of goods (PWXG) and in the price of Canadian imports of goods (PMG) and services (PMS). The resulting proportionate drop in national output is somewhat greater in 1958 than in 1964 (3 per cent versus 2.5 per cent), since in 1964 there were higher marginal import requirements and other factors reflecting the greater degree of capacity utilization that reduced the real value of induced expenditure. In both periods the proportionate fall in domestic output is less than half the proportionate fall in foreign output that induced it. Domestic prices are almost unaffected by the fall in activity and the 1 per cent reduction in foreign prices. This stickiness of prices in response to relatively small changes in output, partic-

[2]Six quarters was selected as one 'reasonable' planning horizon (i.e., a period for which sufficiently accurate forecasts of exogenous variables are available).

TABLE 3

SIXTH-QUARTER EFFECTS OF SIX-QUARTER SIMULATIONS, 1Q58-2Q59 AND 1Q64-2Q65
(Shocked-Control)

Variables →		YGNE	GBAL	RSR	Y/P	C	I	M	X	PGNE	NU/NL	R03	WPH
Units →		Millions of current $			Millions of 1957 $					1957=1.0	Percentage Points		Cents
Effects of Exogenous Disturbances													
World Activity													
AWI - 5%	2Q59	-228	-62	-72	-244	-81	-80	-62	-107	.003	.92	-.03	-1.0
PWXG, PMG, PMS - 1%	2Q65	-344	-94	-82	-280	-110	-81	-89	-142	-.002	.89	-.02	-2.6
Consumption													
CD + 50 million	2Q59	71	23	-25	79	76	25	32	-5	-.001	-.32	0	.3
CD + 65 million	2Q65	110	35	-42	85	100	25	43	-6	.001	-.29	-.01	1.0
Investment													
IME + INRC + 100 million	2Q59	176	42	-47	193	75	155	61	-3	-.003	-.76	.28	.7
IME + INRC + 130 million	2Q65	175	54	-36	210	88	179	76	-5	-.003	-.67	.36	2.7
Effects of Policy Instruments													
Government Expenditure													
GNW + 75 million, GW + 25 million	2Q59	184	-50	-22	143	60	56	64	-16	.004	-.61	.24	1.6
GNW + 97.5 million, GW + 32.5 million	2Q65	266	-61	-41	139	76	50	76	-19	.010	-.44	.28	3.2
Government Transfer													
GTR + 100 million	2Q59	78	-59	-9	86	85	21	29	-6	-.001	-.31	.19	.2
GTR + 130 million	2Q65	107	-74	-18	89	103	18	36	-6	.001	-.27	.22	.7
Tax Rate Change													
RW1, RW2, RW3, RW4	2Q59	-20	19	2	-22	-23	-6	-8	1	0	.07	-.05	.0
+ 1%	2Q65	-39	38	7	-36	-40	-6	-14	3	0	.10	-.10	.2
Depreciation													
PMG, PMS, PWXG	2Q59	229	56	24	197	55	62	-31	25	.003	-.65	-.02	2.1
+ 5%	2Q65	279	66	6	164	53	49	-40	19	.009	-.40	0	3.6
Government Expenditure													
GNW + 100 million	2Q59	187	-51	-26	135	60	52	66	-17	.006	-.50	.23	1.4
GNW + 130 million	2Q65	264	-62	-45	136	74	48	79	-19	.010	-.38	.28	2.7

ularly at low levels of capacity utilization, is a recurring feature in our six-quarter simulation results. The proximate reason is that the unit-labour-cost variable moves up, at first, in response to moderate decreases in aggregate demand under conditions of less than full employment. This is because aggregate money wages, (WP)(NEPP), fall proportionately slightly less than output (YGPK). Since the unit-labour-cost variable has large positive coefficients (largest in the current period) in the price (PGNE) equation, we can find (e.g., in 1958) that in the sixth quarter PGNE stays level or even rises slightly in response to a 5 per cent drop in world activity and a 1 per cent drop in world prices. By the time eight to twelve quarters have elapsed, this perverse price movement is usually eliminated.

For the second experiment we chose to increase constant-dollar personal expenditure on consumer durables (CD) by seven-tenths of 1 per cent of private gross national expenditure (YGPK). Again the procedure was tested in both periods. For the 1958 period this implied an injection of $50 million; for the 1964 period the implied stimulus was $65 million. The induced changes in real expenditure ($\Delta(Y/P)$ - initial ΔCD) by the sixth quarter are much more substantial (as a per cent of total output) in 1958-1959, the years of relatively low utilization rates (see Table 3). Finally, similar experiments were carried out assuming an autonomous increase in expenditure on machinery and equipment in both periods. Once again the results were markedly sensitive to the rate of capacity utilization represented in the initial conditions.

4. Short-Term Effects of Individual Stabilization Policies

In order to assess the flexibility and efficacy of various stabilization policies in the context of this model, we need to establish some standards of reference. First, it is necessary to consider the size of the offset required to counterbalance a given shock to the economy (see above). Then we must make some assumptions about how far ahead the behaviour of the exogenous variables can be forecast with reasonable accuracy. As a basis for our investigation and analysis, we consider the alternate implications of assuming that the exogenous variables can be forecast for either three or six quarters ahead. Thus we assess

alternative policies on the basis of their effects both three and six quarters later.

Tables 1 and 2 show, amongst other things, quarter by quarter effects (in both 1958 and 1964) of three policies: an increase in government nonwage expenditure, a 15 per cent increase in the size of the banking system, and a similar monetary expansion coupled with declines in short- and long-term U.S. interest rates. In the lower part of Table 3 we show the sixth-quarter effects of four additional policy actions: an increase in government transfer payments to persons, an increase in personal income tax rates of 1 percentage point in each income class, a reduction of 5 per cent in the external value of the Canadian dollar (represented by 5 per cent increases in PMG, PMS, and PWXG), and a reduction in government wage and nonwage expenditure. In the fiscal policy simulations the sizes of the policy dosages in 1964 are constrained to be the same proportion of the capacity level of YGNE as those in 1958. For example, transfer payments are increased by $100 million per quarter in 1958 and by $130 million per quarter in 1964, since full-capacity YGNE was 30 per cent higher in 1964 than in 1958.

Two results reported in the six-quarter simulations of various policy instruments can be combined to throw light on an interesting question. What would be the increase in personal income tax rates (RW1, RW2, RW3 and RW4) necessary to maintain budget balance (i.e., deficit or surplus equal to control) given any increase in government nonwage expenditure (GNW) during our low and high capacity utilization periods and what would be the resulting balanced budget multipliers? In a recent article [1], Michael Evans has examined the balanced budget multiplier properties of several U.S. models contrasting them in particular with values derived from the Wharton model. He distinguishes an ex ante and ex post formulation of the balanced budget multiplier concept. The ex ante multiplier is defined as the result of the change in tax rates that would deliver a volume of receipts equal to the volume of expenditures in the first period based upon the first-period control values of the relevant tax base. The ex post multiplier is derived by permitting tax rates to vary continuously in order to keep the budget in balance. We are concerned with the latter formulation. The results reported here are virtually linear combinations of the values reported in Table 3; although simula-

tions were run for five quarters beginning in 1Q58 and 1Q64 with personal tax rate changes and government nonwage expenditure changes imposed together, subject to the constraint that the budget surplus or deficit is equal in the control and shocked runs. This constraint allows for interactions of the two policies. In effect we attempt to provide an answer to the fiscal policy maker who, at the first quarter of a year, asks, What would be the real income effects of any change in government expenditure and compensating change in tax rates imposed now and maintained over this and the following four quarters?

Not surprisingly our multipliers are relatively low, being less than unity with respect to constant-dollar expenditure. They fall from .86 to .69 over the period 2Q58 to 1Q59 and from .74 to .62 over the period 2Q64 to 1Q65. With respect to current-dollar gross national expenditure (YGNE), they are slightly over unity, averaging slightly less than 1.2 in the 1958 period and less than 1.1 in the 1964 period. During the 1958 period, budget balance is maintained by a rise of 3.1 percentage points in each of the basic personal income tax rates, balancing an increase of $100 million in GNW; and during the 1964 period by a rise of 2.3 percentage points in each rate balancing an increase of $130 million in GNW. These results are a reflection of the relatively low multipliers associated with the stimulus of government nonwage expenditure. These low multipliers, relative to those of the Wharton model, are due chiefly to foreign trade leakages. Thus, in contrast to the Wharton model, only about half of the expenditure is recovered from induced tax receipts. For the Wharton model the induced tax recapture alone very nearly offsets the expenditure increase with a resulting need for only modest changes in personal tax rates.

By comparing the individual effects of various kinds of policy actions with the effects of typical exogenous 'shocks' (shown at the top of Table 3) we can study what the model says about the short-term efficacy of various policies. The revealed ability of various policies to offset destabilizing influences (shocks) depends, of course, on the point in time at which the evaluation is made. Thus we can make a comparison, for example, in the sixth quarter of the real output effects of a 5 per cent devaluation as a means of offsetting the domestic effects of a 5 per cent reduction in world activity and a 1 per cent drop in world prices.

Our experiment shows that the devaluation would offset slightly less than 80 per cent of the effects of a world depression on real aggregate expenditure in 1958 and about 60 per cent of these effects in 1964. If we use an increase in government nonwage expenditure (GNW) to counter the effects of a world depression, it remains the case that the relative effectiveness of the policy is greater in 1958 than in 1964. 'Equivalent' injections of government expenditure offset a considerably larger percentage of the fall in constant-dollar expenditure during the period of relatively low levels of capacity utilization. Data presented in Tables 1, 2 and 3 enable us to make numerous comparisons of this nature by simply pairing various policies and disturbances.

To assess the likelihood of strong interacting effects between external shocks and offsetting policies, we also did simulations for both 1958 and 1964 that combined these events simultaneously (e.g., a decline in world activity and an offsetting devaluation policy). The combined effects were almost exactly equal to the sum of the effects of the two experiments run separately.

Although this pairing of shocks and policy instruments is a convenient way of examining the short-term effects of a range of alternative policies, it is nevertheless a very artificial exercise. Aside from ignoring the uncertainty surrounding the structure of the model and the forecasts of the exogenous variables, as we do in all our experiments, the one by one examination of policies forces us to ignore what is perhaps the most important aspect of the problem, namely, the choice of a mix of policies best adapted to several conflicting policy goals. In these circumstances the most powerful and fast-acting policies may not be at all appropriate, because we need a range of policies having differential effects on the various target variables. Using a pair of monetary and fiscal policies to indicate the type of analysis open to us, we now turn to the larger question of the effects of sets of policies.

5. Analysis of the Effects of Policy Mixes

We take as our example of a policy mix a change in government nonwage expenditure (fiscal policy), coupled with a change in

short-term interest rates (monetary policy). To illustrate the effects of various dosages of this combination, we have prepared two sets of charts. The first set, Chart 4 for 1958 and Chart 5 for 1964, shows what combinations of real output and changes in foreign exchange reserves would be achieved six quarters after the initiation of a particular mix of economic policies. The second set, Chart 6 for 1958 and Chart 7 for 1964, evaluates the achievements of economic policy in terms of output and foreign exchange reserves three quarters after the application of a particular set of policies. Our experiments assume that fiscal policy takes longer to implement than monetary policy. Thus we assume that an 'easy' monetary policy lowers short-term interest rates by one-half the target amount in the first quarter, with the remainder of the reduction being achieved in the second quarter. Because of the various lags involved, fiscal policy does not achieve the full target change in government expenditures until the third quarter. Half of the target is achieved in the second quarter and none in the first quarter.

The vertical axis of each graph measures the size of the quarterly alteration in government nonwage expenditure as a per cent of current-dollar full-capacity expenditure in the first quarter. The zero point on the axis represents a level of GNW equal to its actual value in the quarter. The horizontal axis measures (in basis points) the change in short-term interest rates (R03). Lines on the charts join pairs of policies that produce the same impact on a particular target variable after six (three) quarters of application. It is possible to draw such lines for any endogenous variable whose value is thought to have some independent effect on welfare. On our charts we have drawn iso-target lines only for changes in total output (the relatively flat lines in Charts 4 to 7) and for foreign exchange reserves (the steeper lines). Since RDX1 is a preliminary model, we think it more important to illustrate how such a model can be used to assess alternative policies than to provide a complete set of charts purporting to show the effects of all feasible sets of policies on all potential target variables.

The income variable we use here is equal to private real expenditure (YGPK) plus the deflated value of government expenditure (GW + GNW/PGNE). The line marked "2%", for example, joins those pairs of monetary and fiscal policies that would make income

Chart 4

INCOME AND BALANCE OF PAYMENTS CONSEQUENCES
OF MIXES OF MONETARY AND FISCAL POLICY
6Q AFTER POLICY CHANGE IN 1Q58

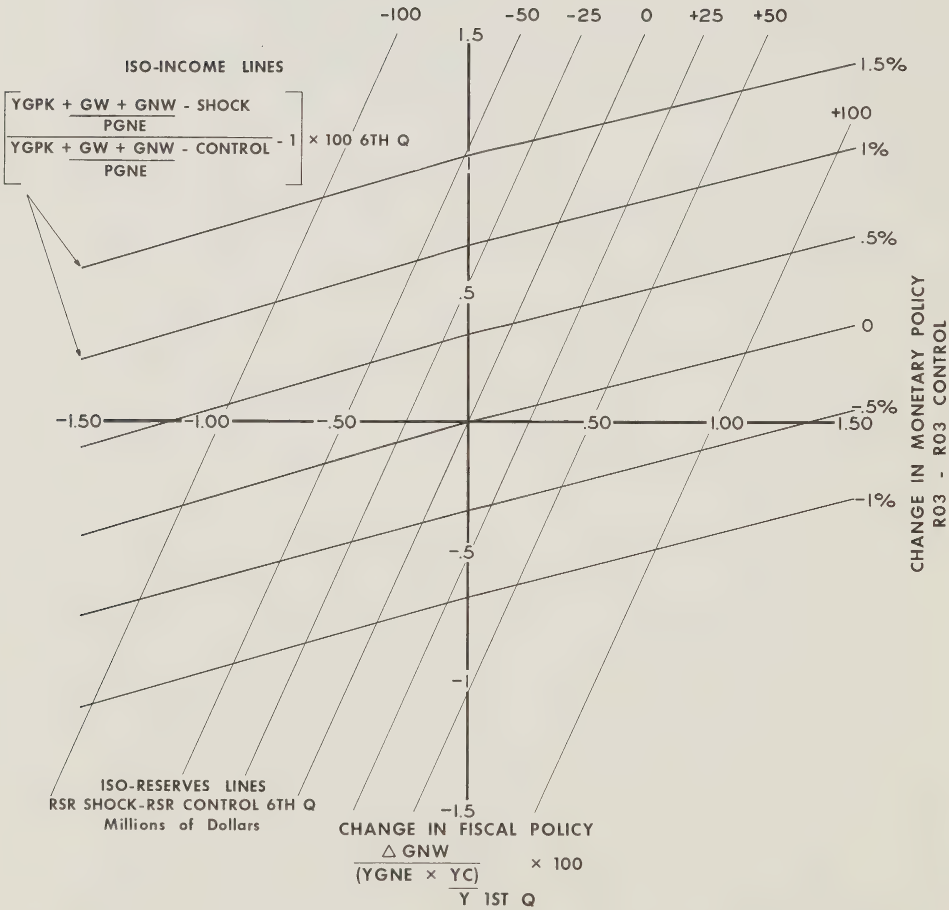


Chart 5

INCOME AND BALANCE OF PAYMENTS CONSEQUENCES OF MIXES OF MONETARY AND FISCAL POLICY 6Q AFTER POLICY CHANGE IN 1Q64

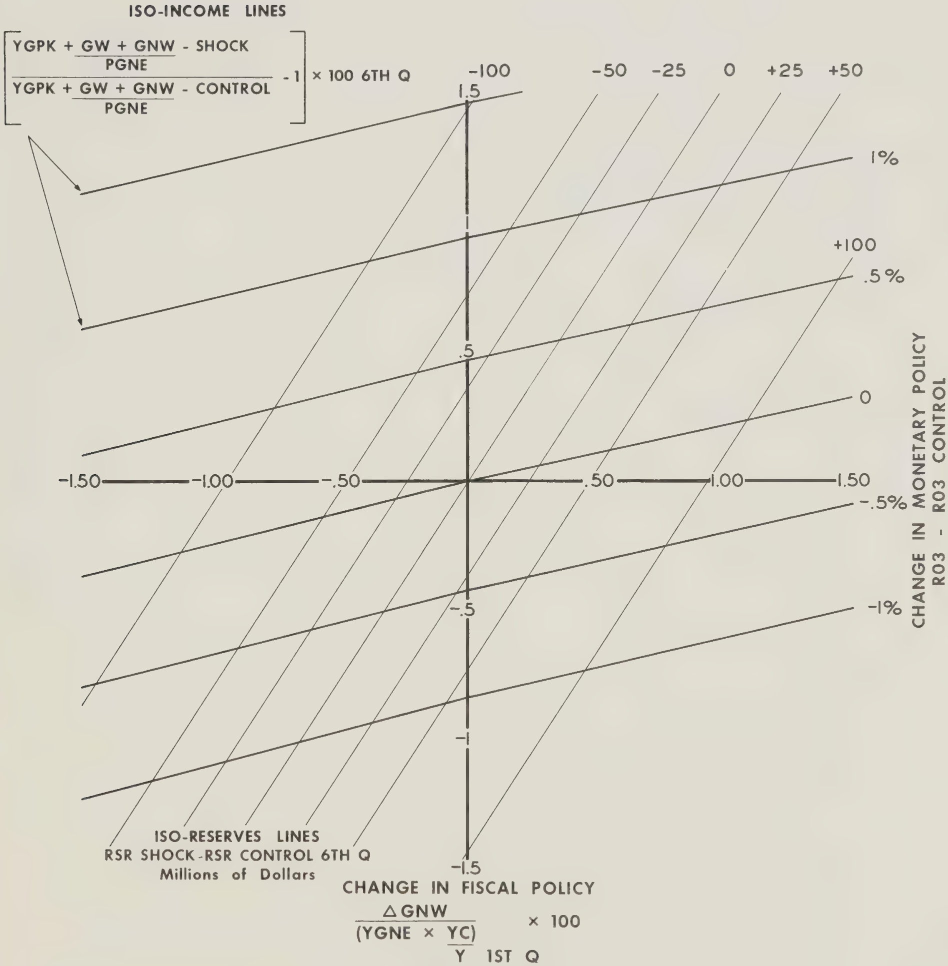


Chart 6

INCOME AND BALANCE OF PAYMENTS CONSEQUENCES OF MIXES OF MONETARY AND FISCAL POLICY 3Q AFTER POLICY CHANGE IN 1Q58

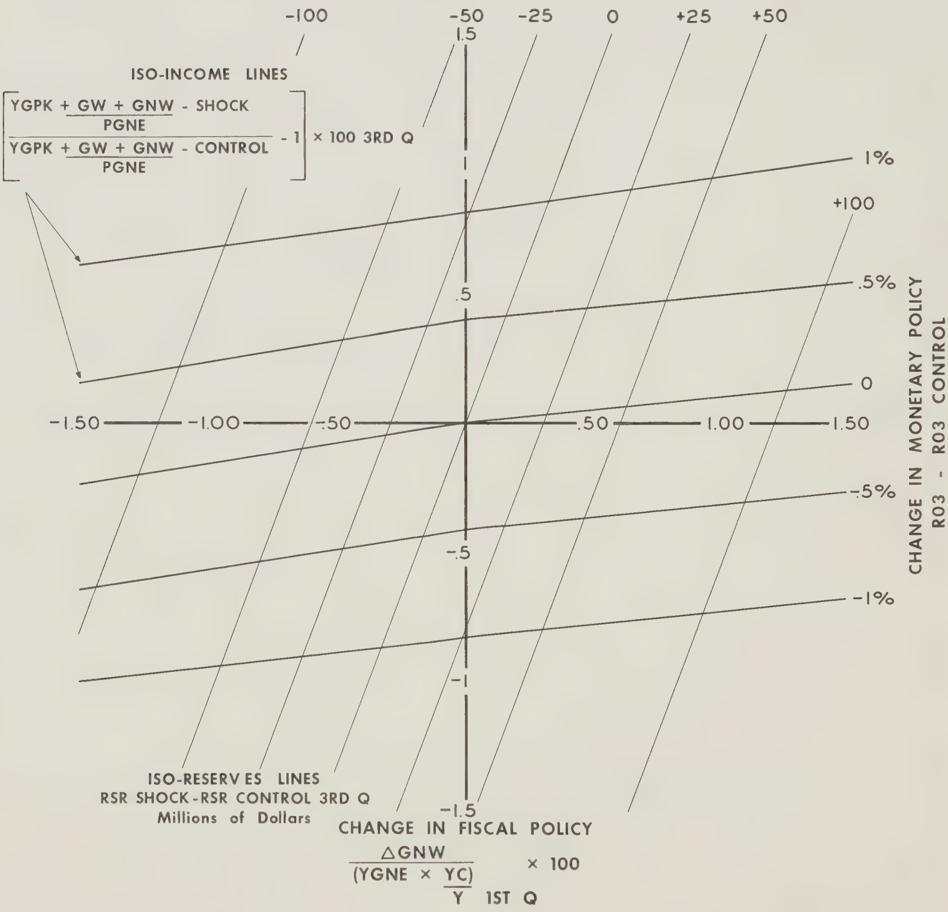
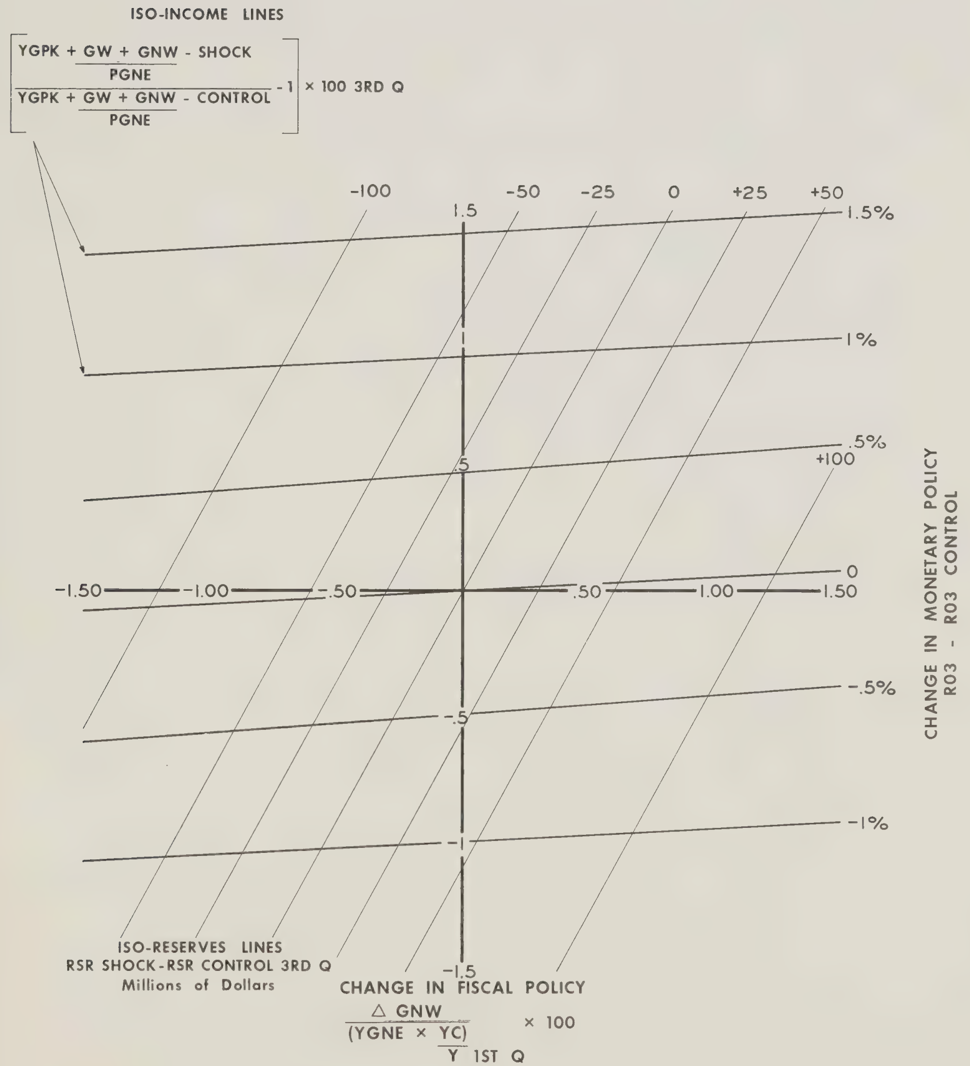


Chart 7

INCOME AND BALANCE OF PAYMENTS CONSEQUENCES OF MIXES OF MONETARY AND FISCAL POLICY 3Q AFTER POLICY CHANGE IN 1Q64



in the specified quarter 2 per cent higher than the control solution value. The "iso-reserves" lines on Charts 4 and 5, for example, join pairs of policies that produce the same change, during the sixth quarter, in official exchange reserves (RSR) as the change defined by the balance of payments equation and measured in millions of Canadian dollars. For example, the line marked "-25" (million) joins those mixes that would lead to a sixth-quarter value of RSR $25 million less than in the control solution.

Because of the non-linearities in RDX1, the "iso-reserves" and "iso-income" lines have different slopes and positions in 1958 than in 1964. The "iso-income" lines are further apart in 1964, reflecting lower real expenditure multipliers when the economy is operating at close to full capacity. These lines are also less steep in this simulation and slightly concave in both periods. The "iso-reserves" lines in both periods are steeper than the "iso-income" lines, illustrating the fact that, given the present structure of RDX1, monetary policy instruments have a short-run comparative advantage in attaining a reserve target. Because lags in the effects of monetary policy on reserves are much shorter than on income and because the corresponding difference in the lags of fiscal policy is much less, the relative slopes of the "iso-income" and "iso-reserves" lines depend on the quarter chosen for assessing their effects. If a quarter earlier (later) than the sixth were chosen for such an evaluation, the differences in the slopes would be more (less) pronounced. This phenomenon can be illustrated by comparing Charts 4 and 5 (representing sixth-quarter evaluations) with Charts 6 and 7 (representing third-quarter evaluations). The "iso-reserves" lines are equidistant and parallel in both periods, but somewhat less steep in 1964, reflecting greater marginal import requirements in 1964 and the consequent need for higher interest rates in order to hold reserves constant for any given expansion in aggregate demand.

A logical extension of our procedure would be to construct iso-target lines for unemployment rates, rates of price increase, and any other variables thought to be important policy targets. Another approach would be to consider a trade-off between two competing policy targets. This is often not a useful exercise, since, if it is done outside a simulation context, one cannot hold constant the various exogenous variables. Even if it is done by simulation, such a two-target trade-off assumes that there are

only two targets and one available instrument of policy. Using a model like RDX1, we can construct trade-off relationships based on more realistic assumptions about possibilities and constraints. For example, in the present case where we are considering the use of two instruments, we can construct the locus of pairs of values for policies that achieve a given value for one target variable and then plot the attainable pairs of values of two other target values.

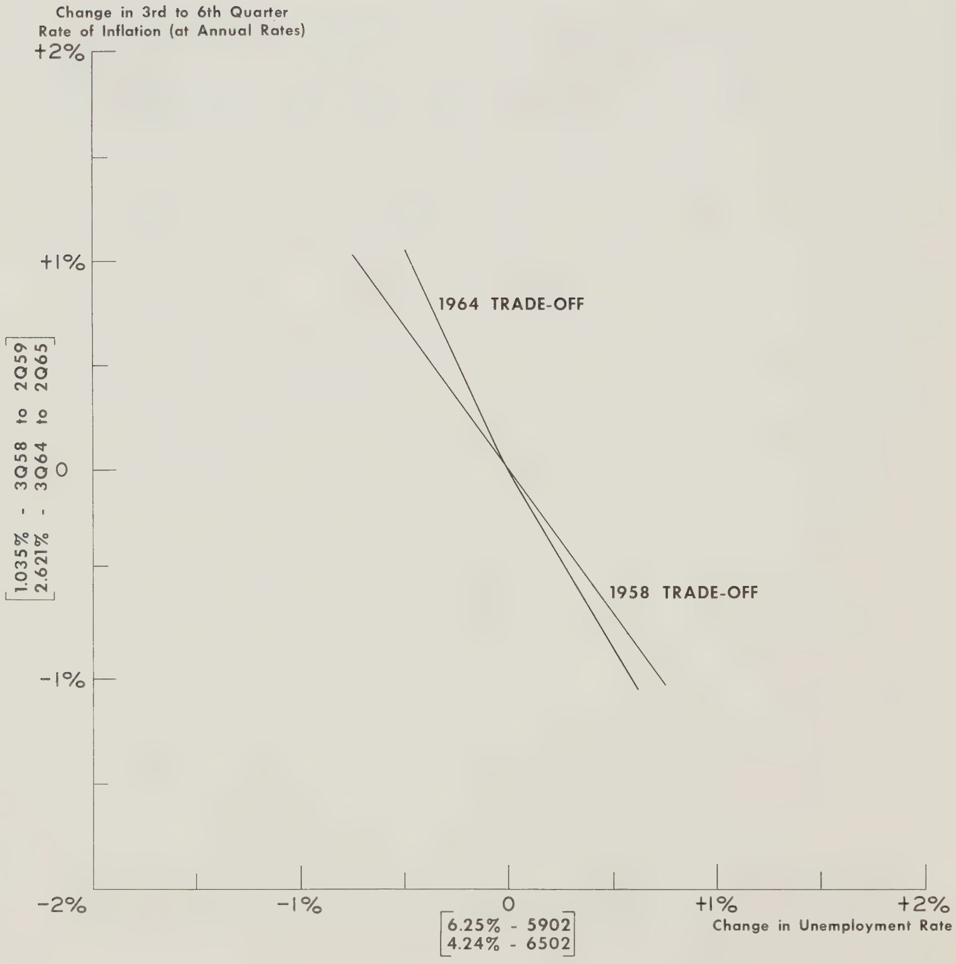
To illustrate this procedure we considered the pairs of policy values lying along the "iso-reserves" line RSR = 0, and in Chart 8 drew lines joining the implied values of changes in the unemployment rate ($\Delta\frac{NU}{NL}$ x 100) and changes in the implicit aggregate private price deflator ($\frac{\Delta PGNE}{PGNE}$ x 100).[3] Thus, Chart 8 shows the attainable trade-offs between the unemployment rate and the rate of change in prices if various values of monetary and fiscal policies are chosen, subject to the constraint that the change in the level of foreign exchange reserves is kept equal to the value in the control solution. The 1964 line is steeper than the 1958 line, showing that expansionary policies used in 1964 would lead to less change in unemployment, relative to the change in prices, than would similar expansionary policies used in 1958. The 1958 line is almost straight within the range drawn, while the 1964 line is somewhat convex to the origin, illustrating the increasing nonlinearity of the unemployment-to-price-level trade-off at higher levels of capacity utilization.

The results of the above experiments, of course, should not be considered as an explicit guide to policy selection. These simulations are only intended to reveal the characteristics of RDX1 and to show how a model of this type can be used to analyze in a consistent way the consequences of a considerable range of policy alternatives. Before any reliance can be placed on the actual numerical relationships produced by the model, one must

[3]In precise terms, ΔNU/NL is the sixth-quarter simulation value of NU/NL minus the sixth-quarter control value. ΔPGNE/PGNE is defined as four-thirds times the change in PGNE from the third to sixth quarter under simulation (as a percentage of the third-quarter simulation value) minus the change in PGNE from the third to sixth quarter in the control solution (as a percentage of the third-quarter control value of PGNE).

Chart 8

TRADE-OFFS BETWEEN INFLATION AND UNEMPLOYMENT USING POLICY MIXES THAT KEEP FOREIGN EXCHANGE RESERVES CONSTANT



take explicit account of the uncertainties surrounding its dynamic causal structure, the estimated coefficients in the equations, and the forecasts of the exogenous variables.

6. Some Additional Experiments

In order to assess the sensitivity of our simulation results to particular features of the structure of RDX1, we did a number of experiments that suppressed or altered certain of the model's mechanisms. The key relationships whose importance we wished to assess were those that dampen the induced expenditure effects of a change in bond-financed fiscal policy. We selected for particular attention the influence of induced changes in foreign trade, the degree of utilization of capital stock, tax and transfer payments, and prices.

The method followed in these tests was quite simple. We subjected the model several times to expansionary fiscal policies of the sort described earlier, each time removing the effects of the induced change in one of the above mechanisms by setting values of relevant variables equal to the values they took in the initial control solution. The specific changes and results are reported in the following text. As well, Table 4 shows the resulting induced changes in several key endogenous variables six, eight, and sixteen quarters after the application of an expansionary fiscal policy in 1Q58 (GNW + 100 million) and 1Q64 (GNW + 130 million). The first lines in the table show the consequences of expansionary fiscal policy if RDX1 is left as is, while the lower lines show the consequences of this policy if the specified mechanism is made inoperative.

(a) Foreign Trade

The effects of induced foreign trade are revealed by our first experiment, which sets both exports and imports at their control solution values. Table 4 shows, for example, that, after six quarters of fiscal expansion starting in 1Q58, induced changes in constant-dollar expenditure are more than ten times as great if no induced changes occur in imports and exports. The differences are somewhat less striking in 1964, because the remaining supply

TABLE 4

EFFECTS OF FISCAL POLICY ON VARIANTS OF RDX1
(Results reported after six, eight and sixteen quarters of simulations starting in 1Q58 and 1Q64)

Variables →		YGNE	GBAL	RSR	Y/P	C	I	M	X	PGNE	NU/NL	R03	WPH
Units →		Millions of current $			Millions of 1957 $					1957=1.0	Percentage Points		Cents
Fiscal policy applied to unaltered RDX1													
GNW + 100 million	2Q59	187	-51	-26	135	60	52	66	-17	.006	-.50	.23	1.4
	4Q59	208	-49	-22	160	81	68	73	-17	.005	-.53	.25	1.7
	4Q61	213	-48	-15	174	105	51	57	-10	.004	-.50	.20	3.0
GNW + 130 million	2Q65	266	-62	-45	136	74	48	79	-19	.010	-.38	.28	2.7
	4Q65	306	-56	-48	156	102	59	91	-21	.012	-.44	.32	4.0
	4Q67	271	-70	-31	139	106	30	54	-13	.008	-.02	.18	4.6
(a) Foreign trade experiments													
Trade leakages removed													
GNW + 100 million Δ(X-M) = control	2Q59	480	20	94	454	158	128	-1	-1	.001	-1.57	.26	2.3
	4Q59	688	58	146	655	262	211	0	0	0	-2.26	.33	3.7
	4Q61	1,358	98	255	1,073	597	370	1	-12	.021	-3.51	.43	15.8
GNW + 130 million Δ(X-M) = control	2Q65	654	29	91	436	189	105	0	-8	.014	-1.21	.29	6.4
	4Q65	1,011	84	140	612	309	167	1	-14	.025	-1.48	.37	10.9
	4Q67	1,336	167	159	727	530	225	0	-19	.033	-.68	.11	19.7
Alternative import equation													
GNW + 100 million MG with $1/4 \sum_{0}^{3} (1.03 - NU/NL)_{t-i}$	2Q59	196	-48	-23	146	64	56	64	-18	.006	-.52	.23	1.5
	4Q59	220	-46	-20	172	87	73	73	-17	.004	-.58	.25	1.7
	4Q61	223	-48	-16	171	106	50	59	-10	.004	-.49	.21	3.2
GNW + 130 million MG with $1/4 \sum_{0}^{3} (1.03 - NU/NL)_{t-i}$	2Q65	287	-55	-39	155	82	52	74	-20	.010	-.44	.29	2.8
	4Q65	364	-47	-44	179	116	67	90	-24	.013	-.55	.33	4.5
	4Q67	299	-65	-26	146	118	25	59	-15	.009	.02	.16	5.3

(b) Capacity utilization held constant in import equation													
GNW + 100 million; $1/4 \sum_{0}^{3} (Y/YC)_{t-i}$ = control	2Q59	222	-42	-5	174	73	62	55	-20	.005	-.61	.24	1.5
	4Q59	257	-38	-8	211	102	86	65	-20	.004	-.70	.26	1.9
	4Q61	271	-37	-7	209	132	68	59	-11	.005	-.63	.22	3.8
GNW + 130 million; $1/4 \sum_{0}^{3} (Y/YC)_{t-i}$ = control	2Q65	314	-50	-29	176	90	57	65	-22	.010	-.50	.28	3.1
	4Q65	415	-36	-34	204	130	74	85	-27	.015	-.44	.34	5.3
	4Q67	306	-63	-29	148	123	23	50	-15	.011	.10	.13	5.8
(c) No induced changes in taxes and transfers													
GNW + 100 million; ΔGBAL = control - ΔGNW	2Q59	231	-99	-29	174	97	74	85	-21	.006	-.55	.33	1.9
	4Q59	279	-99	-26	222	139	103	103	-23	.005	-.66	.37	2.5
	4Q61	394	-99	-22	299	231	114	110	-20	.008	-.74	.41	5.5
GNW + 130 million; ΔGBAL = control - ΔGNW	2Q65	323	-130	-55	180	124	67	101	-23	.011	-.46	.41	3.3
	4Q65	439	-130	-44	227	186	88	131	-26	.015	-.63	.51	3.0
	4Q67	479	-130	-53	259	252	75	109	-23	.013	-.13	.40	7.5
(d) No induced price changes													
GNW + 100 million; PGNE, PND = control	2Q59	137	-54	-22	160	61	54	62	-13	0	-.62	.25	1.2
	4Q59	199	-50	-18	209	87	76	73	-13	0	-.73	.27	1.5
	4Q61	216	-49	-10	206	116	60	56	-6	0	-.69	.22	3.2
GNW + 130 million; PGNE, PND = control	2Q65	204	-75	-43	181	77	48	71	-12	0	-.59	.33	1.5
	4Q65	271	-71	-53	238	122	62	91	-13	0	-.93	.38	4.6
	4Q67	248	-78	-27	206	147	37	52	-6	0	-.23	.19	6.4

constraints are more strongly operative then than in 1958. Since this result showed us, amongst other things, that import leakages are the dominant cause of RDX1's relatively small expenditure multipliers, we also ran a simulation that altered the structure of the import equation while leaving imports endogenous. As the non-linear interaction of aggregate demand and capacity utilization is apparently necessary to get an accurate import equation, we kept this basic idea but substituted the degree of utilization of the labour force[4] for that of the capital stock. This new variable gave us an import equation with a somewhat poorer fit than the original, and produced only a slightly smaller import leakage when the model was subjected to expansionary fiscal policy under either 1958 or 1964 conditions. Thus our high import leakages are not simply a result of the particular capacity utilization variable we used in building the RDX1 trade equations.

(b) The Degree of Utilization of the Capital Stock

Although the size of the existing capital stock in relation to its desired level is the basic determinant of investment expenditure, our next experiment, recorded in Table 4, was not intended to shortcut this mechanism but rather to remove any foreign trade effects of the induced change in the import equation's capacity utilization term. When the four-quarter moving average of Y/YC is set equal to its control solution, the effects of any increase in capacity utilization on the propensity to import are eliminated. As can be seen from the results, this change increases induced constant-dollar expenditure after eight quarters by a factor of about 2 both in 1958 and in 1964. Thus changes in the degree of capacity utilization have a substantial impact, acting through the import equation, on the size of expenditure multipliers. Naturally, these effects would be much larger if we also cut off the induced investment in construction, machinery and equipment, and inventories.

[4]The new labour force utilization variable is equal to a four-quarter moving average of (1.03 - NU/NL), where NU/NL is the unemployment rate expressed as a proportion. 1.03 is used on the assumption that 3 per cent is a reasonable estimate of frictional unemployment.

(c) Tax and Transfer Payments

Our expansionary fiscal policy is assumed to be bond-financed to the extent that induced tax and transfer revenues do not cover the larger government expenditures. The basic simulation shown at the top of Table 4 indicates that about half the increase in government expenditure is offset by increases in tax and transfer revenues. It follows that if these induced revenues did not arise, the multiplier effects of the initial change in expenditures would be much greater. The experiment constraining the change in the government national accounts balance (GBAL) to be equal to the initial change in government expenditure shows that induced real expenditures are more than twice as great if the 'automatic stabilizers' are shut off. Certain more involved experiments we have undertaken with the tax and transfer mechanisms (reported in [3]) suggest, however, that if the initial expenditure shock is cyclical, rather than a once-and-for-all change, the automatic stabilizers do not necessarily decrease the induced changes in expenditure.

(d) Prices

Finally, we ran simulations designed to show how much larger the multipliers of RDX1 would be if induced price increases did not lead to various reductions in real domestic expenditure. The last results recorded in Table 4 show that when domestic prices are set equal to their control solution values, the real expenditure multipliers do increase very considerably, especially in 1964. This is as might be expected, since the induced price increases, and hence the importance of the various price effects on aggregate demand, are much greater in 1964 than in 1958.

7. Conclusion and Prospects

In performing various simulations with RDX1, we discovered a number of respects in which the model ought to be improved. On the basis of these ideas, we have embarked on further research. In this further research, we are interested not only in improving the less plausible elements of the structure of RDX1, but also in building a model that can be used to deal with a larger variety of questions. It is too early to give a precise description of

the structure of RDX2, but we can indicate some of the main features of the research.

We are concentrating to a considerable degree on developing data for the market values of domestic assets held both by residents and non-residents. Thereby we hope to make sensible use of the balance sheet positions of the major sectors of the economy in determining asset prices, interest rates, and real expenditures. We also hope to include explicit expectation mechanisms for prices and other important variables.

Our plans for the use of RDX2 include detailed linkage with a U.S. model. We are therefore developing foreign trade and payments equations using a comprehensive scheme of disaggregation.[5] Fairly complete specification of the demands for a broad spectrum of real and financial assets will, we hope, enable us to improve upon existing explanations of international capital flows. We also plan to make explicit the market for foreign exchange.

The wage, price, and employment equations of RDX1, taken as a group, were responsible for a number of its less plausible simulation results. We suspect that some of these problems resulted from working with data at too high a level of aggregation. In RDX2 we plan to explain a greater number of expenditure price deflators, and, on the employment side, to treat separately at least some of the heterogeneous groups in the labour force.

The inclusion of measures of various private sector balance sheet items in RDX2 may also permit us to arrive at better explanations of the accumulation of various types of consumer durables, and to treat wage and nonwage income differently. This latter split would enable us to make use of our detailed tax model, which explains separately the taxation of wage and nonwage incomes.[6] Other additions to the government sector may include explicit treatment of provincial and municipal revenues and expenditures, and fuller explanations of the methods of obtaining finance for all levels of government.

[5]See [2] for a tentative presentation of the theoretical framework that we are employing.

[6]The model is presented in [5], pp. 22-55.

The financial sector of RDX2, as already indicated, will be much more comprehensive than that of RDX1. We thus hope to improve the explanation of the prices and yields of various financial assets and also to use the derived balance sheet ratios in explaining some of the non-price effects of credit conditions on expenditures.

To go much further in advertising RDX2 is probably unwise, lest optimistic forecasts make our subsequent performance seem disappointing. It is enough to say that we have heeded the lessons of RDX1 and are making at least some concrete plans for improvements.

A P P E N D I X   A

SECTORAL BREAKDOWN OF RDX1

A. PRIVATE AGGREGATE DEMAND

1. Consumer Expenditures
    1. Consumer Expenditure, Durables (CD) - Equation 2
    2. Consumer Expenditure, Non-Durables (CND) - Equation 7
    3. Consumer Expenditure, Services (CS) - Equation 8

2. Residential Construction
    1. Construction Costs (CLC) - Equation 6
    2. Housing Starts (HST) - Equation 21
    3. Investment, Residential Construction (IRC) - Equation 26
    4. Stock of Houses (STH) - Equation 68
    5. Conventional Mortgage Rate (RC) - Equation 63
    6. Price of Houses (PH) - Equation 57

    Technical Relationships and Identities
    1. Estimated Logarithm of Investment in Non-Residential Construction (LINE) - Equation 36
    2. Estimated Logarithm of Investment in Residential Construction (LIRE) - Equation 37
    3. Mortgage Rate (RM) - Equation 66

3. Gross Private Business Investment
    1. Investment, Machinery and Equipment (IME) - Equation 22
    2. Investment, Non-Residential Construction (INRC) - Equation 23
    3. Change in Non-Farm Business Inventories (INV) - Equation 25

    Technical Relationships and Identities
    1. Cash Flow Ratio (CFR) - Equation 3
    2. Trended Cash Flow Ratio (CFRT) - Equation 4
    3. Stock of Non-Farm Inventories (H) - Equation 16
    4. Stock of Machinery and Equipment (KME) - Equation 27
    5. Desired Stock of Machinery and Equipment (KMED) - Equation 28
    6. Gap between Desired and Actual Stock of Machinery and Equipment (KMEG) - Equation 29
    7. Trended Stock of Machinery and Equipment (KMEY) - Equation 30
    8. Stock of Non-Residential Construction (KNR) - Equation 31
    9. Desired Stock of Non-Residential Construction (KNRD) - Equation 32
    10. Gap between Desired and Actual Stock of Non-Residential Construction (KNRG) - Equation 33
    11. Trended Stock of Non-Residential Construction (KNRY) - Equation 34
    12. Undistributed Corporate Profits (PCRT) - Equation 53
    13. Long-Term Interest Rate Index (RLCI) - Equation 65
    14. Real Domestic Product less Agriculture (Y) - Equation 89
    15. Capacity Real Domestic Product less Agriculture (YC) - Equation 95

4. Foreign Trade
    1. Imports of Goods (MG) - Equation 40
    2. Imports of Services (MS) - Equation 41
    3. Exports of Goods (XG) - Equation 87
    4. Exports of Services (XS) - Equation 88

B. EMPLOYMENT, PRICES, AND INCOME DISTRIBUTION

1. Employment, Labor Force and Hours
    1. Average Hours Worked, Paid Non-Agricultural Workers (HAW) - Equation 17
    2. Paid Workers, Private Industry (NEPP) - Equation 43
    3. Employed, Unpaid Workers (NEUP) - Equation 44
    4. Labor Force (NL) - Equation 45

   Technical Relationships and Identities
    1. Trended Average Hours Worked (HAWT) - Equation 18
    2. Paid Workers, Total (NEP) - Equation 42
    3. Total Unemployed (NU) - Equation 51

2. Wages
    1. Private Wage Rate Per Man-hour (WPH) - Equation 85

   Technical Relationships and Identities
    1. Government Wage Expenditure (GW) - Equation 15
    2. Private Wages (WP) - Equation 84
    3. The Wage Bill (WSSL) - Equation 86

3. Prices
    1. Implicit Price Index, Consumer Durable Expenditure (PD) - Equation 55
    2. Implicit Private GNE Deflator (PGNE) - Equation 56
    3. Implicit Price Index, Consumer Non-Durable Expenditure (PND) - Equation 58
    4. Price Index, Goods Exports (PXG) - Equation 60
    5. Price Index, Service Exports (PXS) - Equation 61

   Technical Relationships and Identities
    1. Inventory Stock/Sales Ratio (HSL) - Equation 19
    2. Trended Inventory Stock/Sales Ratio (HSLT) - Equation 20
    3. Private Unit Labour Costs (ULC) - Equation 83

4. Income Components
    1. Dividends Paid to Canadians (DIVC) - Equation 10
    2. Dividends Paid to Foreigners (DIVF) - Equation 11
    3. Corporate Profits (PC) - Equation 52

   Technical Relationships and Identities
    1. Disposable Personal Income (YD) - Equation 96
    2. Permanent Real Disposable Personal Income (YDP) - Equation 97
    3. Gross National Expenditure (YGNE) - Equation 98
    4. Private Non-Farm Real Gross National Expenditure (YGPK) - Equation 99
    5. Personal Income (YP) - Equation 100
    6. Simulated Income-Expenditure Residual (YRES) - Equation 101

C. THE GOVERNMENT SECTOR

1. Personal Direct Taxes Sub-Model
   1. Total Number of Taxable Persons (NT) - Equation 46
   2. Total Personal Direct Taxes (TP) - Equation 79
   3. Assessed Taxable Income (YAS) - Equation 90

   Technical Relationships and Identities
   1. Accrued Personal Income Tax (AY) - Equation 1
   2. Number of Taxable Persons, Assessed Incomes between 0 and $3,000 (NT03) - Equation 47
   3. Number of Taxable Persons, Assessed Incomes between $3,000 and $5,000 (NT35) - Equation 48
   4. Number of Taxable Persons, Assessed Incomes between $5,000 and $10,000 (NT51) - Equation 49
   5. Number of Taxable Persons, Assessed Incomes over $10,000 (NT10) - Equation 50
   6. Assessed Taxable Income between 0 and $3,000 (YAS1) - Equation 91
   7. Assessed Taxable Income between $3,000 and $5,000 (YAS2) - Equation 92
   8. Assessed Taxable Income between $5,000 and $10,000 (YAS3) - Equation 93
   9. Assessed Taxable Income over $10,000 (YAS4) - Equation 94

2. Other Tax Equations

   Government Revenue
   1. Corporate Tax Accruals (TCA) - Equation 73
   2. Customs Duties (TCUS) - Equation 74
   3. Excise Taxes (TEX) - Equation 76
   4. Federal Sales Tax (TS) - Equation 80

   Technical Relationships and Identities
   1. Government Balance (GBAL) - Equation 14
   2. Total Indirect Taxes (TI) - Equation 77
   3. Taxable Corporate Profits (PCT) - Equation 54

3. Unemployment Insurance Fund Sub-Model
   1. Claimants Insured by Unemployment Insurance Fund (CL) - Equation 5
   2. Average Level of Enrolment in Unemployment Insurance Fund (INS) - Equation 24
   3. Unemployment Insurance Benefits (UIB) - Equation 81
   4. Unemployment Insurance Receipts (UIR) - Equation 82

   Technical Relationships and Identities
   1. Employed Contributors to Unemployment Insurance Fund (EMPS) - Equation 13

D. THE FINANCIAL SECTOR

1. Chartered Banks' Demand Deposits (DD) - Equation 9
2. Chartered Banks' Loans to Business (LB) - Equation 35
3. Chartered Banks' Loans to Persons (LP) - Equation 38
4. Short-Term Interest Rate (R03) - Equation 62
5. Long-Term Interest Rate (RLC) - Equation 64
6. Chartered Banks' Total Loan Authorizations over $100,000 (TA) - Equation 70

Technical Relationships and Identities

1. Chartered Banks' More Liquid Assets (ELA) - Equation 12
2. Chartered Banks' Personal Savings Deposits and Non-Personal Term Deposits (PNPS) - Equation 59
3. Chartered Banks' Total Major Assets (TBA) - Equation 71
4. Chartered Banks' Trended Total Major Assets (TBAT) - Equation 72
5. Chartered Banks' Total Deposits (TD) - Equation 75
6. Chartered Banks' Total Loans (TL) - Equation 78

E. INTERNATIONAL CAPITAL FLOWS

1. Net Long-Term Capital Inflows (LTK) - Equation 39
2. Net Private Short-Term Capital Inflows (STK) - Equation 69

Technical Relationships and Identities

1. Change in Reserves as Defined by the Balance of Payments (RSR) - Equation 67

APPENDIX B

RDX1 STRUCTURAL EQUATIONS

O.L.S. = Ordinary least squares

T.S.F. = Two-stage Fisher

$\overline{R}^2$ = Adjusted coefficient of determination

SEE = Standard error of estimate

COV = Coefficient of variation, as a percentage

D/W = Durbin/Watson statistic

O.L.S. coefficients above, T.S.F. below

The absolute values of Student's t statistics are in brackets below each coefficient.

1. Accrued Personal Income Tax, 1Q50 - 4Q65

$$AY = \sum_{i=1}^{i=4} RW_i \, (YAS_i - NT_i YEX_i) - RDC \, (DIVC)$$

2. Consumer Expenditure, Durables, 1Q52 - 4Q65

$$\begin{array}{llllll} CD = & 340.6 & - 0.0211 \; Q1(YDP) & + 0.0077 \; Q2(YDP) & - 0.0318 \; Q3(YDP) & + 0.3500 \; YDP \\ & (3.06) & (8.31) & (3.38) & (7.11) & (11.68) \\ & 373.0 & - 0.0211 & 0.0076 & - 0.0315 & 0.3584 \\ & (1.91) & (8.20) & (3.30) & (6.73) & (7.00) \end{array}$$

$$\begin{array}{lll} + 0.0662 \left(\frac{YD}{PGNE} - YDP\right) & - 0.2551 \; YDP \left(\frac{PD}{PGNE}\right) & - 44.62 \; RLC_{t-3} \\ (2.47) & (4.52) & (2.86) \\ 0.0627 & - 0.2721 & - 41.53 \\ (2.33) & (2.70) & (1.92) \end{array}$$

O.L.S. $\bar{R}^2 = 0.962$
SEE = 33.83
COV = 5.107
D/W = 1.97

T.S.F. $\bar{R}^2 = 0.962$
SEE = 33.87
COV = 5.11
D/W = 1.95

3. Cash Flow Ratio

$$CFR = \left(\frac{CCAC + PCRT}{PGNE}\right)/CFRT$$

4. Trended Cash Flow Ratio, 1Q50 - 4Q65

$$\begin{array}{ll} CFRT = 272.1 & + 8.698 \; T \\ \quad\;\; (9.01) & (13.88) \end{array}$$

O.L.S. $\bar{R}^2 = 0.752$
SEE = 92.61
COV = 14.05
D/W = 1.48

5. Claimants on the Unemployment Insurance Fund, 1Q52 - 4Q65

$$\begin{array}{llllll} CL = & -0.2128 & - 0.00328 \; T & + 0.1064 \; INS & + 1.218 \; Q1(NU) & + 1.0621 \; Q2(NU) \\ & (2.32) & (3.30) & (3.00) & (22.42) & (13.78) \\ & -0.2548 & - 0.00372 & 0.1225 & 1.218 & 1.066 \\ & (1.98) & (2.77) & (2.45) & (21.14) & (13.43) \end{array}$$

+ 0.7248 Q3(NU) + 1.020 Q4(NU)
(6.76) (11.71)

0.7318 1.025
(6.64) (11.30)

O.L.S. $\bar{R}^2 = 0.953$
SEE = 0.0416
COV = 11.26
D/W = 1.92

T.S.F. $\bar{R}^2 = 0.953$
SEE = 0.0417
COV = 11.28
D/W = 1.91

6. Construction Costs, 3Q55 - 4Q65

$\ln CLC - \ln CLC_{t-4}$ = -0.00356 + 0.0418 $(\ln INRC - LINE)_{t-1}$
(.61) (1.93)

-0.00315 0.0445
(.49) (1.90)

+ 0.0902 $(\ln IRC - LIRE)_{t-1}$ + 0.1246 $(\ln WC - \ln WC_{t-4})$
(3.88) (1.09)

0.0850 0.0781
(3.45) (.63)

+ 0.1122 $(\ln L - \ln L_{t-4})$ + 0.0311 $(\ln R03 - \ln R03_{t-4})$
(2.60) (3.34)

0.1249 0.0377
(2.26) (3.40)

+ 0.0279 DVST
(5.03)

0.0298
(5.15)

O.L.S. $\bar{R}^2 = 0.741$
SEE = 0.0136
D/W = 1.56

T.S.F. $\bar{R}^2 = 0.735$
SEE = 0.0138
D/W = 1.52

7. Consumer Expenditure, Non-Durables, 1Q52 - 4Q65

CND = 705.7 - 0.1010 Q1(YDP) - 0.0779 Q2(YDP) - 0.0845 Q3(YDP) + 0.9796 YDP
(8.92) (30.58) (26.18) (14.76) (12.73)

589.8 - 0.1012 - 0.0775 - 0.0830 0.8580
(5.49) (30.00) (25.38) (14.65) (7.82)

$$+\ 0.0673 \left(\frac{YD}{PGNE} - YDP\right) - 0.5556\ YDP \left(\frac{PND}{PGNE}\right)$$
(1.94) (6.20)

0.0559 - 0.4128
(1.63) (3.23)

O.L.S. $\overline{R}^2 = 0.992$	T.S.F. $\overline{R}^2 = 0.992$
SEE = 44.39	SEE = 45.54
COV = 1.63	COV = 1.67
D/W = 2.34	D/W = 2.13

8. Consumer Expenditure, Services, 1Q52 - 4Q65

$$CS = -149.7 - 0.000403\ Q1(YDP) + 0.00856\ Q2(YDP) - 0.0113\ Q3(YDP) + 0.3813\ YDP$$
(5.84) (.19) (3.97) (5.32) (82.47)

-152.1 - 0.000403 0.00857 - 0.0113 0.3818
(5.94) (.19) (3.98) (5.32) (82.51)

O.L.S. $\overline{R}^2 = 0.992$	T.S.F. $\overline{R}^2 = 0.992$
SEE = 32.29	SEE = 32.30
COV = 1.64	COV = 1.64
D/W = .91	D/W = .91

9. Demand Deposits, 1Q55 - 4Q65

$$\frac{DD - DD_{t-1}}{TBA} = 0.0840 - 0.0158\ Q1 - 0.00561\ Q2 - 0.00473\ Q3 - 0.2526\ \frac{DD_{t-1}}{TBA}$$
(3.24) (5.37) (2.92) (1.52) (6.11)

0.0742 - 0.0152 - 0.00549 - 0.00560 - 0.2426
(2.73) (4.91) (2.84) (1.71) (5.60)

$$+\ 0.03655\ \frac{YGNE}{TBA} - 0.00825\ R03 + 0.000247\ S2_{t-1}$$
(1.12) (7.82) (2.51)

0.0484 - 0.00869 0.000262
(1.38) (7.42) (2.61)

O.L.S. $\overline{R}^2 = 0.840$	T.S.F. $\overline{R}^2 = 0.838$
SEE = 0.0043	SEE = 0.0044
D/W = 1.75	D/W = 1.77

10. Dividends Paid to Residents, 1Q53 - 4Q65

$$DIVC = -22.00 - 13.23\ Q2 - 19.70\ Q3 + 0.0781\ (PC + CCAC - TCA)$$
(2.91) (2.87) (4.26) (20.13)

-21.39 - 13.23 - 19.68 0.0778
(2.79) (2.87) (4.26) (19.77)

$$+ \underset{(20.13)}{0.0440} (PC + CCAC - TCA)_{t-1} + \underset{(20.13)}{0.0195} (PC + CCAC - TCA)_{t-2}$$

$$\underset{(19.77)}{0.0438} \qquad \underset{(19.77)}{0.0195}$$

$$+ \underset{(20.13)}{0.0049} (PC + CCAC - TCA)_{t-3}$$

$$\underset{(19.77)}{0.0049}$$

O.L.S. $\overline{R}^2$ = 0.891
SEE = 13.59
COV = 11.96
D/W = 0.57

T.S.F. $\overline{R}^2$ = 0.891
SEE = 13.59
COV = 11.97
D/W = 0.57

11. Dividends Paid to Non-Residents, 1Q53 - 4Q65

$$DIVF = \underset{(3.98)}{53.19} - \underset{(5.65)}{37.93} Q1 - \underset{(8.78)}{57.23} Q2 - \underset{(8.97)}{57.97} Q3 + \underset{(2.16)}{15.89} D8$$

$$\underset{(3.53)}{48.69} - \underset{(5.53)}{37.26} \quad - \underset{(8.71)}{56.88} \quad - \underset{(8.93)}{57.80} \quad \underset{(1.84)}{13.84}$$

$$+ \underset{(7.81)}{0.0586} (PC + CCAC - TCA) + \underset{(7.81)}{0.0329} (PC + CCAC - TCA)_{t-1}$$

$$\underset{(7.88)}{0.0613} \qquad \underset{(7.88)}{0.0345}$$

$$+ \underset{(7.81)}{0.0146} (PC + CCAC - TCA)_{t-2} + \underset{(7.81)}{0.0037} (PC + CCAC - TCA)_{t-3}$$

$$\underset{(7.88)}{0.0153} \qquad \underset{(7.88)}{0.0038}$$

O.L.S. $\overline{R}^2$ = 0.874
SEE = 16.43
COV = 12.76
D/W = 2.08

T.S.F. $\overline{R}^2$ = 0.874
SEE = 16.46
COV = 12.78
D/W = 2.09

12. Chartered Banks More Liquid Assets

ELA = TBA - TL - OCS - VC - BCD

13. Employed Contributors to Unemployment Insurance Fund

EMPS = INS - CL

14. Government Balance

$$GBAL = TP + TOP + TCA + TI + TW + GIM + SSPS + UIR + GX - GW - GNW - MP - GTR$$
$$- UIB - GINT - SUBS - ASST$$

15. Government Wage Expenditure

$$GW = WG(NEPG) + (GWI)$$

16. Stock of Non-farm Inventories

$$H = H_{t-1} + INV$$

17. Average Weekly Hours Worked, Paid Non-agricultural Workers, 1Q54 - 4Q65

$$\begin{array}{lllllll} HAW - HAW_{t-1} = & 53.36\ Q1 & + 54.88\ Q2 & + 53.97\ Q3 & + 52.70\ Q4 & - 0.01323\ T(Q1) \\ & (8.68) & (8.98) & (8.47) & (8.39) & (0.84) \\ & 53.86 & 55.41 & 54.55 & 53.24 & - 0.01710 \\ & (4.68) & (4.84) & (4.57) & (4.54) & (1.01) \end{array}$$

$$\begin{array}{llll} - 0.02495\ T(Q2) & - 0.03608\ T(Q3) & - 0.01908\ T(Q4) & + 0.0006242\ (YGPK + \frac{GNW}{PGNE}) \\ (1.49) & (2.01) & (1.00) & (3.13) \\ - 0.02972 & - 0.04125 & - 0.02462 & 0.0007059 \\ (1.61) & (2.04) & (1.09) & (2.34) \end{array}$$

$$\begin{array}{lll} + 0.01895 \frac{NL}{NU} & - 5.087\ WPH & - 1.230\ HAW_{t-1} \\ (2.41) & (4.03) & (8.51) \\ 0.01577 & - 5.272 & - 1.243 \\ (1.69) & (2.84) & (4.69) \end{array}$$

O.L.S.	$\bar{R}^2 = 0.973$	T.S.F.	$\bar{R}^2 = 0.973$
	SEE = 0.209		SEE = 0.209
	D/W = 1.90		D/W = 1.84

18. Trended Average Weekly Hours Worked, 3Q53 - 4Q65

$$\begin{array}{lllllll} HAWT = & 41.13\ Q1 & + 43.21\ Q2 & + 42.48\ Q3 & + 40.75\ Q4 & - 0.0340\ T(Q1) & - 0.0423\ T(Q2) \\ & (126.5) & (130.5) & (146.5) & (138.1) & (5.53) & (6.88) \end{array}$$

$$\begin{array}{ll} - 0.0607\ T(Q3) & - 0.0276\ T(Q4) \\ (11.13) & (5.06) \end{array}$$

O.L.S. $\bar{R}^2 = 0.912$
SEE = 0.294
COV = 0.74
D/W = 1.41

19. Inventories Sales Ratio

$$HSL = \frac{H_{t-1}}{YGPK + (GNW/PGNE) - INV}$$

20. Trended Inventories Sales Ratio, 1Q50 - 4Q65

$$\underset{(49.2)}{HSLT = 1.302} - \underset{(3.7)}{0.002057}\ T$$

O.L.S. $\bar{R}^2 = 0.172$
SEE = 0.08
COV = 6.70
D/W = 2.0

21. Housing Starts, 1Q57 - 4Q65

$$\begin{array}{lllllll} HST = & 28.58 & - 20.21\ Q1 & + 7.984\ Q2 & + 7.766\ Q3 & + 9.350\ WW & + 9.258\ (\frac{PH}{CLC}) \\ & (.96) & (8.67) & (3.76) & (3.89) & (2.55) & (3.16) \\ & 17.19 & - 20.20 & 7.810 & 7.500 & 8.708 & 10.94 \\ & (.55) & (8.62) & (3.65) & (3.72) & (2.34) & (3.37) \end{array}$$

$$\begin{array}{llll} - 12.03\ RM_{t-1} & + 2.662\ (RM - RLC)_{t-1} & + 2.868\ (\frac{CMHC}{PH}) & + 5.810\ (\frac{CMHC}{PH})_{t-1} \\ (3.85) & (1.27) & (1.31) & (3.69) \\ - 12.55 & 3.244 & 3.083 & 5.771 \\ (3.96) & (1.50) & (1.40) & (3.65) \end{array}$$

O.L.S. $\bar{R}^2 = 0.922$
SEE = 3.52
COV = 9.96
D/W = 1.84

T.S.F. $\bar{R}^2 = 0.921$
SEE = 3.55
COV = 10.03
D/W = 1.83

22. Investment, Machinery and Equipment, 1Q53 - 4Q65

$$\begin{array}{llllll} IME - 0.05\ KME_{t-1} = & -212.8\ Q1 & - 132.7\ Q2 & - 271.0\ Q3 & - 233.6\ Q4 & + 0.1654\ Q1(KMEG) \\ & (3.84) & (1.87) & (3.97) & (3.72) & (5.58) \\ & -269.3 & - 205.9 & - 341.5 & - 298.1 & 0.1604 \\ & (3.40) & (2.02) & (3.47) & (3.30) & (5.27) \end{array}$$

$$\begin{array}{llll} + 0.1665\ Q2(KMEG) & + 0.1442\ Q3(KMEG) & + 0.1977\ Q4(KMEG) & + 317.9\ CFR \\ (5.61) & (5.22) & (7.40) & (5.09) \\ 0.1585 & 0.1409 & 0.1929 & 383.2 \\ (5.18) & (5.01) & (7.05) & (4.23) \end{array}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.878	$\bar{R}^2$	= 0.875
SEE	= 38.46	SEE	= 38.94
COV	= 45.26	COV	= 45.83
D/W	= .87	D/W	= .88

23. Investment, Non-residential Construction 1Q53 - 4Q65

$$INRC - 0.01\ KNR_{t-1} = \underset{(2.47)}{-1.052\ T(Q1)} + \underset{(4.52)}{1.878\ T(Q2)} + \underset{(11.50)}{4.714\ T(Q3)} + \underset{(7.33)}{2.942\ T(Q4)}$$

$$+ \underset{(13.25)}{0.0299\ KNRG} + \underset{(15.13)}{299.1\ RLCI}$$

O.L.S.	
$\bar{R}^2$	= 0.931
SEE	= 37.36
COV	= 10.46
D/W	= 1.25

24. Level of Enrolment in Unemployment Insurance Fund, 1Q52 - 4Q65

INS =	Q1	Q2	Q3	Q4	NEP(D5)
	-0.4422	- 0.7563	- 0.9460	- 0.7588	+ 0.9695
	(.48)	(.80)	(.96)	(.79)	(3.70)
	-2.375	- 2.770	- 3.033	- 2.796	1.524
	(2.14)	(2.34)	(2.53)	(2.39)	(4.78)

NEP(D6)	T1(NEP)(D5)	T2(NEP)(D6)
+ 1.002	+ 0.00218	- 0.00346
(4.90)	(1.21)	(2.08)
1.435	0.00151	- 0.00680
(5.77)	(.69)	(3.41)

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.956	$\bar{R}^2$	= 0.952
SEE	= 0.098	SEE	= 0.102
COV	= 2.52	COV	= 2.63
D/W	= 1.12	D/W	= 1.20

25. Change in Non-farm Business Inventories, 1Q56 - 4Q65

INV =		Q1	Q2	Q3	H_{t-1}
	626.7	+ 326.4	+ 160.3	- 39.45	- 0.1351
	(3.80)	(2.83)	(1.91)	(0.85)	(3.02)
	610.6	366.8	58.80	- 83.63	- 0.0830
	(3.68)	(3.05)	(0.55)	(1.54)	(1.63)

$(YGPK - CS - INV + \frac{GNW}{PGNE})$	$[(YGPK - CS - INV + \frac{GNW}{PGNE})$
+ 0.1601	- 0.1896
(2.65)	(2.26)
0.0855	- 0.1020
(1.21)	(0.95)

$$- \left(YGPK - CS - INV + \frac{GNW}{PGNE}\right)_{t-1}\Big] \underset{(5.74)}{- 271.9} \; \frac{NU}{\sum_{i=1}^{12} NU_{t-i}/12} \underset{(5.64)}{- 287.9}$$

O.L.S. $\overline{R}^2 = 0.809$
SEE = 72.43
D/W = 1.70

T.S.F. $\overline{R}^2 = 0.797$
SEE = 74.62
D/W = 1.80

26. Investment, Residential Construction, 1Q54 - 4Q65

$$IRC = \underset{(6.62)}{117.2} + \underset{(16.96)}{4.616}\ HST + \underset{(7.69)}{1.958}\ HST_{t-1} + \underset{(3.32)}{0.9238}\ HST_{t-2}$$

$$\underset{(6.56)}{117.9} \quad \underset{(16.42)}{4.600} \quad \underset{(7.70)}{1.958} \quad \underset{(3.29)}{0.9179}$$

O.L.S. $\overline{R}^2 = 0.886$
SEE = 22.06
COV = 5.91
D/W = 1.05

T.S.F. $\overline{R}^2 = 0.886$
SEE = 22.06
COV = 5.91
D/W = 1.05

27. Stock of Machinery and Equipment

$$KME = KME_{t-1} + IME - 0.05\ KME_{t-1}$$

28. Desired Stock of Machinery and Equipment

$$KMED = Y(KMEY)$$

29. Gap between Desired and Actual Stock of Machinery and Equipment

$$KMEG = 0.1000\ (KMED_{t-1} - KME_{t-2}) + 0.1500\ (KMED_{t-2} - KME_{t-3})$$
$$+ 0.3000\ (KMED_{t-3} - KME_{t-4}) + 0.2500\ (KMED_{t-4} - KME_{t-5})$$
$$+ 0.1500\ (KMED_{t-5} - KME_{t-6}) + 0.0500\ (KMED_{t-6} - KME_{t-7})$$

30. Trended Stock of Machinery and Equipment

$$KMEY = 1.903 - 0.0068\ T + 0.0061\ T(D7) - 0.4157\ D7$$

31. Stock of Non-residential Construction

$$KNR = (KNR_{t-1} + INRC) - 0.0100\ KNR_{t-1}$$

32. Desired Stock of Non-residential Construction

$$KNRD = Y(KNRY)\ CFR$$

33. Gap between Desired and Actual Stock of Non-residential Construction

$$KNRG = 0.0600\ (KNRD_{t-2} - KNR_{t-3}) + 0.1100\ (KNRD_{t-3} - KNR_{t-4})$$

$$+ 0.1600\ (KNRD_{t-4} - KNR_{t-5}) + 0.1700\ (KNRD_{t-5} - KNR_{t-6})$$

$$+ 0.1600\ (KNRD_{t-6} - KNR_{t-7}) + 0.1300\ (KNRD_{t-7} - KNR_{t-8})$$

$$+ 0.1100\ (KNRD_{t-8} - KNR_{t-9}) + 0.0700\ (KNRD_{t-9} - KNR_{t-10})$$

$$+ 0.0400\ (KNRD_{t-10} - KNR_{t-11})$$

34. Trended Stock of Non-residential Construction

$$KNRY = 3.103 + 0.0093\ T$$

35. Chartered Banks' Loans to Business, 1Q57 - 4Q65

$$LB - LB_{t-1} = \underset{(4.23)}{-308.0} - \underset{(2.99)}{0.0224}\ Q1(LB_{t-1}) + \underset{(4.09)}{0.0373}\ Q2(LB_{t-1}) + \underset{(6.08)}{0.0437}\ Q3(LB_{t-1})$$

$$- \underset{(3.90)}{0.3111}\ LB_{t-1} + \underset{(4.16)}{0.1514}\ TA + \underset{(2.14)}{0.1286}\ [PGNE\ (IME + INRC + INV)$$

$$- CCAC - PCRT] + \underset{(3.26)}{48.62}\ R03$$

O.L.S. $\bar{R}^2 = 0.820$
SEE = 44.28
D/W = 0.92
$\rho = 0.419$

36. Estimated Logarithm of Investment in Non-residential Construction, 1Q53 - 4Q65

$$LINE = \underset{(80.6)}{6.152} - \underset{(7.14)}{0.3851}\ Q1 - \underset{(1.70)}{0.9170}\ Q2 + \underset{(2.36)}{0.1276}\ Q3 + \underset{(5.37)}{0.0068}\ T$$

O.L.S. $\bar{R}^2 = 0.718$
SEE = 0.137
COV = 2.14
D/W = .23

(Attach between pages 52 and 53 using gummed edge of reverse side, page 52B)

37. Estimated Logarithm of Investment in Residential Construction, 1Q53 - 4Q65

$$LIRE = \underset{(93.34)}{5.879} - \underset{(8.22)}{0.3660}\,Q1 - \underset{(2.31)}{0.1029}\,Q2 - \underset{(.17)}{0.0076}\,Q3 + \underset{(2.55)}{0.0027}\,T$$

O.L.S. $\bar{R}^2 = 0.65$
SEE = 0.113
COV = 1.92
D/W = .63

38. Chartered Banks' Loans to Persons, 3Q56 - 4Q65

$$LP - LP_{t-1} = -\underset{(7.99)}{533.8} + \underset{(4.62)}{0.0342}\,TBA - \underset{(2.92)}{0.0124}\,Q1(LP_{t-1}) + \underset{(6.37)}{0.0313}\,Q2(LP_{t-1})$$

$$+ \underset{(9.63)}{0.0377}\,Q3(LP_{t-1}) - \underset{(1.96)}{0.0626}\,LP_{t-1} + \underset{(3.80)}{752.7}\left(\frac{ELA}{TBA}\right)_{t-1}$$

$$- \underset{(1.77)}{11.88}\,(RLC - R03)_{t-1}$$

O.L.S. $\bar{R}^2 = 0.890$
SEE = 16.11
D/W = .99
$\rho = 0.480$

39. Net Long Term Capital Inflow, 1Q53 - 4Q65

$$\begin{array}{llllll} LTK = & -\underset{(5.40)}{632.8} & +\underset{(2.88)}{108.2}\,Q1 & -\underset{(2.17)}{77.32}\,Q2 & -\underset{(2.35)}{92.02}\,Q3 & -\underset{(3.76)}{0.00556}\,(T-24)(IME + INRC)\,PGNE \\ & -\underset{(5.21)}{653.2} & \underset{(2.98)}{113.3} & -\underset{(2.22)}{79.80} & -\underset{(2.43)}{96.25} & -\underset{(3.48)}{0.00548} \end{array}$$

$$\begin{array}{llll} +\underset{(6.64)}{0.7430}\,(IME + INRC)\,PGNE & -\underset{(3.77)}{193.0}\,DLK1 & -\underset{(1.40)}{140.3}\,DLK4 & +\underset{(2.36)}{0.3000}\,PMB \\ \underset{(6.32)}{0.7624} & -\underset{(3.92)}{201.4} & -\underset{(1.53)}{153.4} & \underset{(2.24)}{0.2857} \end{array}$$

$$\begin{array}{l} +\underset{(2.74)}{177.0}\,(RLC - RLUS) \\ \underset{(2.37)}{167.0} \end{array}$$

O.L.S. $\bar{R}^2 = 0.534$
SEE = 84.25
D/W = 1.53

T.S.F. $\bar{R}^2 = 0.533$
SEE = 84.39
D/W = 1.54

40. Imports of Goods, 1Q53 - 4Q65

$$MG = \underset{\substack{(6.42)\\1461\\(6.08)}}{1506} + \underset{\substack{(4.83)\\76.95\\(4.71)}}{78.70}\,Q1 + \underset{\substack{(11.43)\\174.3\\(11.34)}}{175.4}\,Q2 + \underset{\substack{(1.54)\\22.65\\(1.49)}}{23.37}\,Q3 + \underset{\substack{(42.85)\\1.074\\(42.11)}}{1.080}\,[0.20\,(CD + CND)$$

$$+ 0.21\,(IME + INRC + IRC) + 0.11\,XG + 0.09\,\frac{GNW}{PGNE} + 0.17\,INV]\,(\tfrac{1}{4})\sum_{i=0}^{3}\left(\frac{Y}{YC}\right)_{t-i}$$

$$- \underset{\substack{(6.43)\\-586.6\\(6.05)}}{607.6}\,\frac{PMG}{PGNE} - \underset{\substack{(6.43)\\-407.4\\(6.05)}}{422.0}\left(\frac{PMG}{PGNE}\right)_{t-1} - \underset{\substack{(6.43)\\-260.7\\(6.05)}}{270.1}\left(\frac{PMG}{PGNE}\right)_{t-2} - \underset{\substack{(6.43)\\-146.7\\(6.05)}}{151.9}\left(\frac{PMG}{PGNE}\right)_{t-3}$$

$$- \underset{\substack{(6.43)\\-65.18\\(6.05)}}{67.52}\left(\frac{PMG}{PGNE}\right)_{t-4} - \underset{\substack{(6.43)\\-16.30\\(6.05)}}{16.88}\left(\frac{PMG}{PGNE}\right)_{t-5}$$

O.L.S. $\bar{R}^2 = 0.977$
SEE = 38.06
COV = 2.72
D/W = 1.38

T.S.F. $\bar{R}^2 = 0.976$
SEE = 38.10
COV = 2.72
D/W = 1.38

41. Imports of Services, 1Q53 - 4Q65

$$MS - DIVF = \underset{\substack{(2.45)\\-41.80\\(2.50)}}{-40.96} + \underset{\substack{(2.24)\\22.07\\(2.25)}}{21.95}\,Q1 + \underset{\substack{(6.85)\\65.73\\(6.86)}}{65.69}\,Q2 + \underset{\substack{(3.12)\\30.07\\(3.12)}}{30.14}\,Q3 + \underset{\substack{(34.94)\\0.0582\\(34.94)}}{0.0582}\,YGNE$$

O.L.S. $\bar{R}^2 = 0.965$
SEE = 24.36
COV = 4.79
D/W = .88

T.S.F. $\bar{R}^2 = 0.965$
SEE = 24.36
COV = 4.79
D/W = .88

42. Paid Workers, Total, All Industries

NEP = (NEPG + NEPP)

43. Paid Workers, Private Industry, 1Q54 - 4Q65

$$NEPP - NEPP_{t-1} = \underset{(6.56)}{6.078} - \underset{(3.35)}{0.07660}\,Q1 + \underset{(15.42)}{0.4346}\,Q2 + \underset{(17.19)}{0.2375}\,Q3$$
$$\underset{(6.32)}{5.996} - \underset{(3.29)}{0.09183} \qquad \underset{(15.12)}{0.4380} \qquad \underset{(16.44)}{0.2410}$$

$$+ \underset{(3.70)}{0.00009238}\left(YGPK + \frac{GNW}{PGNE}\right) - \underset{(2.20)}{0.03897}\,(HAWT - HAW)$$
$$\underset{(2.28)}{0.00007314} \qquad - \underset{(2.47)}{0.06718}$$

$$- \underset{(6.48)}{0.1322}\,HAWT - \underset{(5.41)}{0.3780}\,NEPP_{t-1}$$
$$- \underset{(6.32)}{0.1316} \qquad - \underset{(3.83)}{0.3303}$$

O.L.S. $\bar{R}^2 = 0.977$
SEE = 0.029
D/W = 2.24

T.S.F. $\bar{R}^2 = 0.975$
SEE = 0.030
D/W = 2.40

44. Employed, Unpaid Workers, Private Industry, 1Q53 - 4Q65

$$NEUP = \underset{(1.84)}{0.2948} + \underset{(2.01)}{0.0483}\,Q1 + \underset{(7.68)}{0.1569}\,Q2 + \underset{(11.24)}{0.1656}\,Q3 - \underset{(2.80)}{0.0017}\,T + \underset{(1.47)}{0.000175}\,\frac{YNFC}{PGNE}$$
$$- \underset{(.14)}{0.0439} \qquad \underset{(2.28)}{0.0735} \qquad \underset{(5.32)}{0.1944} \qquad \underset{(9.12)}{0.1814} \qquad - \underset{(.99)}{0.0009} \qquad \underset{(1.36)}{0.000173}$$

$$+ \underset{(6.13)}{0.6643}\,NEUP_{t-1}$$
$$\underset{(4.12)}{0.9009}$$

O.L.S. $\bar{R}^2 = 0.928$
SEE = 0.022
COV = 1.87
D/W = 1.71

T.S.F. $\bar{R}^2 = 0.920$
SEE = 0.023
COV = 1.97
D/W = 2.01

45. Labor Force, 1Q53 - 4Q65

$$\left(\frac{NL}{POP}\right) - \left(\frac{NL}{POP}\right)_{t-1} = \underset{(8.81)}{-0.00960} + \underset{(2.36)}{0.00495}\,Q1 + \underset{(8.52)}{0.0153}\,Q2 + \underset{(15.39)}{0.0210}\,Q3$$
$$\underset{(5.80)}{-0.00961} \qquad \underset{(.88)}{0.00503} \qquad \underset{(7.37)}{0.0153} \qquad \underset{(15.40)}{0.0210}$$

$$+ \underset{(1.32)}{0.0000247} \left[\frac{YGPK}{POP} - \left(\frac{YGPK}{POP}\right)_{t-1}\right] - \underset{(6.35)}{0.6389} \left[\frac{SP}{POP} - \left(\frac{SP}{POP}\right)_{t-1}\right]$$

$$\underset{(.47)}{0.0000255} \qquad \underset{(6.24)}{- 0.6401}$$

O.L.S. $\bar{R}^2 = 0.982$
SEE = 0.0017
D/W = 1.88

T.S.F. $\bar{R}^2 = 0.982$
SEE = 0.0017
D/W = 1.88

46. Total Number of Taxable Persons

$$NT = -0.3053 + \underset{(66.86)}{0.7930} (NEP + NEUP) + \underset{(14.35)}{0.02544}\, T$$

O.L.S. $\bar{R}^2 = 0.987$
SEE = 0.108
COV = 1.98
D/W = .55

47. Number of Taxable Persons, Assessed Incomes between 0 and $3,000

NT03 = N03 (NT)

48. Number of Taxable Persons, Assessed Incomes between $3,000 and $5,000

NT35 = N35 (NT)

49. Number of Taxable Persons, Assessed Incomes between $5,000 and $10,000

NT51 = N51 (NT)

50. Number of Taxable Persons, Incomes over $10,000

NT10 = NT - NT03 - NT35 - NT51

51. Total Unemployed

NU = NL - NEPP - NEUP - NEPG

52. Corporate Profits, 1Q53 - 4Q65

$$PC = \underset{(1.86)}{-1133.}\, Q1 \underset{(2.00)}{- 1169.}\, Q2 \underset{(2.40)}{- 1348.}\, Q3 \underset{(2.04)}{- 1190.}\, Q4 + \underset{(5.68)}{0.1745} [YGNE - INV(PGNE)]$$

$$\underset{(1.36)}{-904.6} \qquad \underset{(1.52)}{- 970.1} \qquad \underset{(1.90)}{- 1164.} \qquad \underset{(1.54)}{- 985.2} \qquad \underset{(5.72)}{0.1941}$$

(Attach between pages 54 and 55 using gummed edge of blank reverse side)

$$- \underset{(5.62)}{1341.}\ WPH + \underset{(3.94)}{1.768}\ (\tfrac{1}{4}) \sum_{i=0}^{i=3} \left(\frac{Y}{NEPP}\right)_{t-i}$$

$$- \underset{(5.71)}{1496.} \qquad \underset{(3.50)}{1.702}$$

O.L.S. $\bar{R}^2 = 0.949$
SEE = 51.49
COV = 5.87
D/W = 1.38

T.S.F. $\bar{R}^2 = 0.948$
SEE = 51.76
COV = 5.90
D/W = 1.45

53. Undistributed Corporation Profits

$$PCRT = PC - DIVF - DIVC - TCA - CCB$$

54. Taxable Corporate Profits, 1Q50 - 4Q65

$$PCT = \underset{(6.85)}{125.1362} + \underset{(8.00)}{7.8163}\ T3 + \underset{(24.32)}{0.7591}\ PC$$

O.L.S. $\bar{R}^2 = 0.997$
SEE = 6.91
COV = 0.89
D/W = 1.98

55. Implicit Price Deflator, Consumer Durable Expenditure, 2Q52 - 4Q65

$$PD - PD_{t-1} = \underset{(.27)}{0.0008}\ Q1 - \underset{(3.03)}{0.0090}\ Q2 - \underset{(4.92)}{0.0162}\ Q3 + \underset{(3.34)}{0.0093}\ Q4$$

$$\underset{(.13)}{0.00038} \quad - \underset{(2.45)}{0.0100} \quad - \underset{(3.39)}{0.0181} \quad \underset{(3.50)}{0.0091}$$

$$+ \underset{(3.57)}{0.7603}\ (PGNE - PGNE_{t-1})$$

$$\underset{(1.59)}{0.9966}$$

O.L.S. $\bar{R}^2 = 0.416$
SEE = 0.0104
D/W = 1.73

T.S.F. $\bar{R}^2 = 0.401$
SEE = 0.011
D/W = 1.77

56. Implicit Price Deflator, Gross National Private Expenditure, 1Q55 - 4Q65

$$PGNE = \underset{(3.48)}{0.1537} - \underset{(3.26)}{0.01096}\ Q1 - \underset{(1.97)}{0.008114}\ Q2 - \underset{(1.30)}{0.005894}\ Q3 + \underset{(1.46)}{0.00009716}\ WP$$

$$\underset{(3.23)}{0.1638} - \underset{(2.20)}{0.01027} \quad - \underset{(1.10)}{0.006954} \quad - \underset{(0.59)}{0.004147} \quad \underset{(1.49)}{0.0001164}$$

$$+ \underset{(4.24)}{0.3745}\ ULC + \underset{(8.50)}{0.3556}\ ULC_{t-1} + \underset{(6.46)}{0.3088}\ ULC_{t-2} + \underset{(4.28)}{0.2339}\ ULC_{t-3}$$

$$\underset{(2.18)}{0.3302} \quad \underset{(6.48)}{0.3376} \quad \underset{(4.50)}{0.3083} \quad \underset{(2.72)}{0.2423}$$

$$+ \underset{(3.29)}{0.1310}\ ULC_{t-4} + \underset{(1.52)}{0.03089}\ PMG_{t-2} + \underset{(1.52)}{0.02270}\ PMG_{t-3} + \underset{(1.52)}{0.01576}\ PMG_{t-4}$$

$$\underset{(2.07)}{0.1395} \quad \underset{(1.32)}{0.02917} \quad \underset{(1.32)}{0.02143} \quad \underset{(1.32)}{0.01488}$$

$$+ \underset{(1.52)}{0.01009}\ PMG_{t-5} + \underset{(1.52)}{0.00567}\ PMG_{t-6} + \underset{(1.52)}{0.00252}\ PMG_{t-7} + \underset{(1.52)}{0.00063}\ PMG_{t-8}$$

$$\underset{(1.32)}{0.00952} \quad \underset{(1.32)}{0.00536} \quad \underset{(1.32)}{0.00238} \quad \underset{(1.32)}{0.00060}$$

$$- \underset{(4.11)}{0.1472} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right] - \underset{(4.11)}{0.0828} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_{t-1}$$

$$- \underset{(2.68)}{0.1200} \quad - \underset{(2.68)}{0.0675}$$

$$- \underset{(4.11)}{0.0368} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_{t-2} - \underset{(4.11)}{0.0092} \left[\tfrac{1}{4} \sum_{i=0}^{3} (HSL - HSLT)_{t-i}\right]_{t-3}$$

$$- \underset{(2.68)}{0.0300} \quad - \underset{(2.68)}{0.0075}$$

O.L.S. $\bar{R}^2 = 0.988$
SEE = 0.0061
COV = 0.58
D/W = 1.19

T.S.F. $\bar{R}^2 = 0.988$
SEE = 0.0063
COV = 0.60
D/W = 1.19

57. Price of Houses, 1Q57 - 4Q65

$$PH = \underset{(1.80)}{72.20} + \underset{(1.44)}{1.406}\ Q1 + \underset{(3.92)}{4.003}\ Q2 + \underset{(2.18)}{2.036}\ Q3 - \underset{(2.85)}{199.3} \frac{STH}{HH} + \underset{(4.74)}{170.2}\ PGNE_{t-1}$$

$$\underset{(1.95)}{79.14} \quad \underset{(1.49)}{1.467} \quad \underset{(3.98)}{4.083} \quad \underset{(2.22)}{2.075} \quad - \underset{(2.99)}{212.3} \quad \underset{(4.82)}{174.0}$$

$$+ \underset{(2.94)}{53.20} \left(\frac{YDP}{HH}\right)_{t-1}$$

$$\underset{(3.05)}{55.62}$$

O.L.S. $\bar{R}^2 = 0.914$
SEE = 1.92
COV = 1.77
D/W = 1.11

T.S.F. $\bar{R}^2 = .914$
SEE = 1.92
COV = 1.77
D/W = 1.14

58. Implicit Price Deflator, Consumer Non-durable Expenditure, 1Q55 - 4Q65

$$\begin{array}{llllll} PND = & 0.3573 & -\ 0.01077\ Q1 & -\ 0.008508\ Q2 & -\ 0.004421\ Q3 & +\ 0.00009876\ WP \\ & (12.11) & (4.89) & (3.77) & (1.74) & (2.24) \\ & 0.3502 & -\ 0.01102 & -\ 0.008837 & -\ 0.005033 & 0.00008730 \\ & (11.07) & (4.96) & (3.88) & (1.91) & (1.82) \end{array}$$

$$\begin{array}{llll} +\ 0.2744\ ULC & +\ 0.1756\ ULC_{t-1} & +\ 0.0988\ ULC_{t-2} & +\ 0.0439\ ULC_{t-3} \\ (7.80) & (7.80) & (7.80) & (7.80) \\ 0.2907 & 0.1861 & 0.1047 & 0.04652 \\ (7.42) & (7.42) & (7.42) & (7.42) \end{array}$$

$$\begin{array}{llll} +\ 0.01098\ ULC_{t-4} & +\ 0.09629\ PMG_{t-2} & +\ 0.07074\ PMG_{t-3} & +\ 0.04913\ PMG_{t-4} \\ (7.80) & (5.94) & (5.94) & (5.94) \\ 0.01163 & 0.09614 & 0.07063 & 0.04905 \\ (7.42) & (5.75) & (5.75) & (5.75) \end{array}$$

$$\begin{array}{llll} +\ 0.03144\ PMG_{t-5} & +\ 0.01769\ PMG_{t-6} & +\ 0.00786\ PMG_{t-7} & +\ 0.00197\ PMG_{t-8} \\ (5.94) & (5.94) & (5.94) & (5.94) \\ 0.03139 & 0.01766 & 0.00785 & 0.00196 \\ (5.75) & (5.75) & (5.75) & (5.75) \end{array}$$

O.L.S. $\bar{R}^2 = 0.987$
SEE = 0.0050
COV = 0.48
D/W = 1.48

T.S.F. $\bar{R}^2 = 0.987$
SEE = 0.0050
COV = 0.48
D/W = 1.46

59. Chartered Banks' Personal Savings and Non-Personal Term Deposits

PNPS = TD - DD - DG

60. Implicit Price Deflator, Goods Exports, 1Q53 - 4Q65

$$\begin{array}{llll} PXG = & 0.3154 & +\ 0.2846\ PGNE & +\ 0.4018\ PWXG \\ & (9.53) & (8.28) & (9.31) \\ & 0.3158 & 0.2822 & 0.4038 \\ & (9.55) & (8.15) & (9.33) \end{array}$$

O.L.S. $\bar{R}^2 = 0.902$
SEE = 0.012
COV = 1.20
D/W = 0.63

T.S.F. $\bar{R}^2 = 0.902$
SEE = 0.012
COV = 1.20
D/W = 0.63

61. Implicit Price Deflator, Service Exports, 1Q53 - 4Q65

$$\begin{array}{llll} PXS = -1.085 & - 0.0198\ Q3 & + 0.5105\ PXG & + 1.593\ PGNE \\ \quad (10.73) & (2.52) & (2.97) & (15.93) \\ \quad -1.179 & - 0.0197 & 0.6614 & 1.535 \\ \quad (10.67) & (2.48) & (3.42) & (13.97) \end{array}$$

O.L.S. $\bar{R}^2 = 0.963$
SEE = 0.024
COV = 2.29
D/W = 1.55

T.S.F. $\bar{R}^2 = 0.962$
SEE = 0.025
COV = 2.31
D/W = 1.56

62. Short-Term Interest Rate, 3Q53 - 4Q65

$$\begin{array}{llll} R03 = 3.180 & + 0.5756\ RTUS & + 0.00060\ [(IME + INV + INRC)PGNE - CCA - PCRT - GBAL] \\ \quad (4.71) & (6.74) & (4.08) \\ \quad 3.214 & 0.5655 & 0.00059 \\ \quad (4.54) & (6.30) & (3.74) \end{array}$$

$$\begin{array}{l} + 0.00050\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-1} \\ \quad (4.08) \\ \quad 0.00049 \\ \quad (3.74) \end{array}$$

$$\begin{array}{l} + 0.00040\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-2} \\ \quad (4.08) \\ \quad 0.00040 \\ \quad (3.74) \end{array}$$

$$\begin{array}{l} + 0.00030\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-3} \\ \quad (4.08) \\ \quad 0.00030 \\ \quad (3.74) \end{array}$$

$$\begin{array}{l} + 0.00020\ [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-4} \\ \quad (4.08) \\ \quad 0.00020 \\ \quad (3.74) \end{array}$$

(Place over page 58 by wet
reverse side)

$$+ \underset{\substack{(4.08)\\ 0.00010\\ (3.74)}}{0.00010}\, [(IME + INRC + INV)PGNE - CCA - PCRT - GBAL]_{t-5}$$

$$- \underset{\substack{(5.74)\\ -10.27\\ (4.98)}}{9.580}\, \frac{ELA}{TBAT} - \underset{\substack{(3.43)\\ -\ 1.569\\ (3.31)}}{1.558}\, \left(\frac{ELA}{TBAT}\right)_{t-1} + \underset{\substack{(4.18)\\ 3.041\\ (3.79)}}{2.713}\, \left(\frac{ELA}{TBAT}\right)_{t-2} + \underset{\substack{(4.98)\\ 3.564\\ (4.35)}}{3.232}\, \left(\frac{ELA}{TBAT}\right)_{t-3}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.876	$\bar{R}^2$	= 0.875
SEE	= 0.338	SEE	= 0.339
COV	= 9.31	COV	= 9.33
D/W	= 1.40	D/W	= 1.38

63. Conventional Mortgage Rate, 2Q54 - 4Q65

$$RC = \underset{\substack{(3.16)\\ 11.28\\ (3.30)}}{10.67} + \underset{\substack{(3.32)\\ 0.2667\\ (3.46)}}{0.2508}\, RLC_{t-1} + \underset{\substack{(5.43)\\ 0.4784\\ (5.30)}}{0.4871}\, RNHA - \underset{\substack{(7.84)\\ -\ 0.003753\\ (7.84)}}{0.003741}\, ALTM + \underset{\substack{(7.09)\\ 0.005665\\ (7.19)}}{0.005457}\, MLTM_{t-1}$$

$$+ \underset{\substack{(3.84)\\ 3.3279\\ (2.85)}}{3.9927}\, \frac{YDP}{HH} - \underset{\substack{(3.25)\\ -\ 10.5470\\ (3.20)}}{10.6980}\, \left(\frac{STH}{HH}\right)_{t-1}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.949	$\bar{R}^2$	= 0.948
SEE	= 0.097	SEE	= 0.098
COV	= 1.44	COV	= 1.45
D/W	= 1.25	D/W	= 1.26

64. Long-Term Interest Rate, 1Q53 - 4Q65

$$RLC = \underset{\substack{(4.71)\\ 0.1195\\ (3.80)}}{0.1321}\, R03 + \underset{\substack{(3.18)\\ 0.2164\\ (3.05)}}{0.2163}\, RLUS + \underset{\substack{(11.28)\\ 0.7071\\ (10.90)}}{0.6969}\, (RLC)_{t-1}$$

O.L.S.		T.S.F.	
$\bar{R}^2$	= 0.975	$\bar{R}^2$	= 0.975
SEE	= 0.125	SEE	= 0.125
COV	= 2.81	COV	= 2.81
D/W	= 1.42	D/W	= 1.47

(Attach between pages 57A and 59 using gummed edge of reverse side, the new page 58)

65. Long-Term Interest Rate, Index

$$RLCI = 0.06 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-2} + 0.11 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-3}$$

$$+ 0.16 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-4} + 0.17 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-5}$$

$$+ 0.16 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-6} + 0.13 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-7}$$

$$+ 0.11 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-8} + 0.07 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-9}$$

$$+ 0.04 \left(\frac{\sum_{i=1}^{i=12} RLC_{t-i}/12}{RLC}\right)_{t-10}$$

66. Mortgage Rate

$$RM = (RC + RNHA)/2$$

67. Change in Official Reserves of Gold and U.S. Dollars

$$RSR = XG(PXG) + XS - MS - MG(PMG) + LTK + STK$$

68. Stock of Houses, 2Q54 - 4Q65

$$\underset{(680.79)}{STH = 0.9997}\, STH_{t-1} + \underset{(2.85)}{0.2240}\, HST + \underset{(5.07)}{0.3723}\, HST_{t-1} + \underset{(4.69)}{0.2750}\, HST_{t-2} + \underset{(4.44)}{0.0961}\, HST_{t-3}$$

$$\underset{(651.6)}{0.9993} \qquad \underset{(2.49)}{0.2015} \qquad \underset{(5.25)}{0.4056} \qquad \underset{(4.99)}{0.3101} \qquad \underset{(4.78)}{0.1100}$$

O.L.S. $\bar{R}^2 = 0.9998$
SEE = 6.62
COV = 0.15
D/W = 2.02

T.S.F. $\bar{R}^2 = 0.9998$
SEE = 6.66
COV = 0.15
D/W = 2.02

69. Net Private Short-Term Capital Inflow, 1Q53 - 4Q65

$$
\begin{array}{llllllll}
STK = & 10.54 & -\ 96.26\ Q3 & +\ 3144\ DRS & -\ 9944\ DRSU & +\ 21705\ DRSF & +\ 152.2\ DSK2 \\
 & (.23) & (2.48) & (1.35) & (2.97) & (1.75) & (2.44) \\
 & 34.88 & -\ 86.14 & 3251 & -\ 9729 & 28074 & 118.1 \\
 & (.61) & (2.10) & (1.33) & (2.78) & (2.10) & (1.77)
\end{array}
$$

$$
\begin{array}{ll}
+\ 102.2\ (R03 - RTUS) & -\ 0.2826\ LTK \\
(2.88) & (1.90) \\
42.93 & -\ 0.1210 \\
(.90) & (.55)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.382$
SEE = 112.9
D/W = 1.72

T.S.F. $\bar{R}^2 = 0.336$
SEE = 116.96
D/W = 1.78

70. Chartered Banks' Total Loan Authorizations over $100,000, 3Q56 - 4Q65

$$
\begin{array}{lllll}
\dfrac{TA - TA_{t-1}}{TBA} = & -0.00507 & +\ 0.1330\ \dfrac{ELA}{TBA} & +\ 0.0193\ (RPR - RLC) & -\ 0.00790\ (RLC - R03) \\
 & (0.29) & (4.26) & (6.88) & (4.76) \\
 & -0.0143 & 0.1312 & 0.0172 & -\ 0.00659 \\
 & (.73) & (4.01) & (5.45) & (3.19)
\end{array}
$$

$$
\begin{array}{ll}
-\ 0.3567\ \dfrac{TA_{t-1}}{TBA} & +\ 0.00186T \\
(5.58) & (8.49) \\
-\ 0.3008 & 0.00166 \\
(3.81) & (6.11)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.729$
SEE = 0.0033
D/W = 1.73

T.S.F. $\bar{R}^2 = 0.721$
SEE = 0.0034
D/W = 1.73

71. Chartered Banks' Total Major Assets

$$TBA = DD + PNPS + DG + CA + OTHL - OTHA$$

72. Chartered Banks' Trended Total Major Assets, 1Q52 - 4Q65

$$
\begin{array}{llllll}
TBAT = & 3611 & +\ 170.2\ T(Q1) & +\ 171.2\ T(Q2) & +\ 172.4\ T(Q3) & +\ 173.3\ T(Q4) \\
 & (16.68) & (34.31) & (35.12) & (35.97) & (36.78)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.968$
SEE = 512.0
COV = 4.29
D/W = .18

73. Corporate Income Tax Accruals, 1Q52 - 4Q65

$$TCA = \underset{(166.8)}{0.9794}\ RPC(PCT) + PLMT$$

$$\underset{(166.6)}{0.9794}$$

O.L.S. $\bar{R}^2 = 0.962$
SEE = 17.46
COV = 4.6
D/W = 1.38

T.S.F. $\bar{R}^2 = 0.962$
SEE = 17.46
COV = 4.60
D/W = 1.38

74. Customs Duties, 1Q52 - 4Q65

$$TCUS = \underset{(61.17)}{0.1201}\ PMG(MG) - \underset{(16.20)}{0.0000189}\ [PMG(MG)]^2 + \underset{(10.78)}{0.9876}\ MG(SUR)PMG$$

$$\underset{(60.28)}{0.1209} \qquad - \underset{(16.25)}{0.0000195} \qquad \underset{(10.74)}{0.9857}$$

$$- \underset{(4.10)}{0.00461}\ Q1\ (MG)PMG$$

$$- \underset{(4.20)}{0.00473}$$

O.L.S. $\bar{R}^2 = 0.963$
SEE = 4.69
COV = 3.64
D/W = 1.04

T.S.F. $\bar{R}^2 = 0.963$
SEE = 4.70
COV = 3.64
D/W = 1.05

75. Chartered Banks' Total Deposits

$$TD = \frac{BCD + BCN - ERL}{DCR} - FLO$$

76. Excise Duties, 1Q52 - 4Q65

$$TEX = \underset{(109.2)}{0.02299}\ [CD(PD) + CND(PND)]$$

$$\underset{(109.2)}{0.02299}$$

O.L.S. $\bar{R}^2 = 0.920$
SEE = 5.60
COV = 7.04
D/W = 1.78

T.S.F. $\bar{R}^2 = 0.920$
SEE = 5.60
COV = 7.04
D/W = 1.78

77. Total Indirect Taxes

$$TI = TS + TCUS + TEX + TMIS$$

78. Chartered Banks' Total Loans

$$TL = LB + LBS + LF + LP + LMUN + LPRV + LH + LM$$

79. Total Personal Taxes, 1Q52 - 4Q65

$$TP = \underset{(97.31)}{1.105}\,(1/3\ AY_{t-1} + 2/3\ AY) - \underset{(1.20)}{0.006558}\ Q1 \sum_{i=1}^{i=4} AY_{t-i} + \underset{(7.41)}{0.04106}\ Q2 \sum_{i=2}^{i=5} AY_{t-i}$$

$$\underset{(97.35)}{1.106} \qquad\qquad - \underset{(1.24)}{0.006793} \qquad\qquad \underset{(7.37)}{0.04081}$$

O.L.S. $\bar{R}^2 = 0.972$
SEE = 27.91
COV = 5.84
D/W = 1.77

T.S.F. $\bar{R}^2 = 0.972$
SEE = 27.92
COV = 5.84
D/W = 1.77

80. Federal Sales Tax, 1Q55 - 4Q65

$$TS = \underset{(74.01)}{0.6326}\ PGNE[CND + CD]\ RSC + \underset{(9.90)}{.5504}\ PGNE[(RSIM)(IME) + .42\ (RSIR)(INRC + IRC)]$$

$$\underset{(73.93)}{0.6329} \qquad\qquad \underset{(9.81)}{0.5478}$$

O.L.S. $\bar{R}^2 = 0.943$
SEE = 19.30
COV = 7.03
D/W = 1.66

T.S.F. $\bar{R}^2 = 0.943$
SEE = 19.30
COV = 7.04
D/W = 1.66

81. Unemployment Insurance Benefits, 1Q52 - 4Q65

$$UIB = \underset{(.49)}{-1.657} - \underset{(1.78)}{.5816}\ Q1(S)(WR)CL + \underset{(2.32)}{.8562}\ Q2(S)(WR)CL$$

$$\underset{(1.12)}{-4.104} - \underset{(2.26)}{.7778} \qquad\qquad \underset{(2.06)}{.7758}$$

$$- \underset{(2.68)}{1.6359}\ Q3(S)(WR)CL - \underset{(9.72)}{3.5823}\ Q4(S)(WR)CL + \underset{(22.04)}{8.7352}\ (WR)CL$$

$$- \underset{(2.45)}{1.5587} \qquad\qquad - \underset{(9.84)}{3.7021} \qquad\qquad \underset{(21.05)}{9.0461}$$

O.L.S. $\bar{R}^2 = 0.966$
SEE = 9.80
COV = 11.94
D/W = 1.62

T.S.F. $\bar{R}^2 = 0.965$
SEE = 9.86
COV = 12.02
D/W = 1.64

82. Unemployment Insurance Receipts, 1Q52 - 4Q65

$$
\begin{array}{llllll}
UIR = & 7.990 + & 10.77\ EMPS + & 6.400\ EMPS(D6) + & 1.321\ Q1(EMPS)S - & 1.703\ Q2(EMPS)S \\
 & (2.82) & (12.31) & (20.80) & (3.83) & (4.90) \\
 & 7.223 & 11.01 & 6.393 & 1.304 & -1.729 \\
 & (2.53) & (12.45) & (20.78) & (3.78) & (4.97)
\end{array}
$$

$$
\begin{array}{ll}
-\ 0.1407\ Q3(EMPS)S + & 0.0585\ Q4(EMPS)S \\
(0.40) & (0.15) \\
-\ 0.1770 & 0.0352 \\
(.50) & (0.09)
\end{array}
$$

O.L.S. $\bar{R}^2 = 0.987$
SEE = 1.79
COV = 3.17
D/W = 2.04

T.S.F. $\bar{R}^2 = 0.987$
SEE = 1.79
COV = 3.17
D/W = 2.04

83. Private Unit Labor Cost

$$
ULC = \frac{(WP)(NEPP)(1/12 \sum_{i=0}^{11} (\frac{YGPK}{YGPK + GNW/PGNE})_{t-i})}{YGPK}
$$

84. Quarterly Compensation per Employee, Private Sector

WP = (WPH)(HAW)(13)

85. Compensation per Man-Hour, Private Sector, 1Q55 - 4Q65

$$
\begin{array}{llll}
\frac{WPH - WPH_{t-4}}{WPH_{t-4}} \times 100 = & -4.830 + & 0.9383 & [\frac{1}{4} \sum_{i=0}^{3} (\frac{PND - PND_{t-4}}{PND_{t-4}} \times 100)_{t-i}] \\
 & (2.02) & (3.92) & \\
 & -4.953 & 0.9308 & \\
 & (1.98) & (3.68) &
\end{array}
$$

$$
\begin{array}{llll}
+\ 0.005172 & [\frac{1}{4} \sum_{i=0}^{3} (\frac{NU}{NL})_{t-i}]^{-2} + & 88.64 & [\frac{1}{4} \sum_{i=0}^{3} (\frac{PC - TCA}{YGPK})_{t-i}] \\
(4.55) & & (2.41) & \\
0.005173 & & 90.36 & \\
(4.42) & & (2.35) &
\end{array}
$$

$$- \underset{(1.63)}{0.2238} \left(\frac{WPH_{t-4} - WPH_{t-8}}{WPH_{t-8}} \times 100 \right)$$

$$- \underset{(1.57)}{0.2208}$$

O.L.S. $\bar{R}^2 = 0.655$
SEE = 1.13
D/W = 1.76

T.S.F. $\bar{R}^2 = 0.655$
SEE = 1.13
D/W = 1.77

86. Wages, Salaries and Supplementary Labor Income

WSSL = WP(NEPP) + WG(NEPG)

87. Exports of Goods, 1Q53 - 4Q65

$$XG = \underset{(3.60)}{1921} - \underset{(10.27)}{294.8}\, Q1 - \underset{(3.53)}{83.08}\, Q2 - \underset{(3.15)}{74.73}\, Q3 + \underset{(35.47)}{1455}\, AWI - \underset{(1.89)}{736.2} \left(Y - XG - \frac{XS}{PXS}\right)/YC$$

$$\underset{(3.23)}{2033} - \underset{(9.39)}{294.5} \qquad - \underset{(3.52)}{83.22} \qquad - \underset{(3.13)}{74.68} \qquad \underset{(35.12)}{1453} \qquad - \underset{(1.47)}{721.2}$$

$$- \underset{(4.11)}{331.3} \frac{PXG}{PWXG} - \underset{(4.11)}{289.9} \left(\frac{PXG}{PWXG}\right)_{t-1} - \underset{(4.11)}{248.5} \left(\frac{PXG}{PWXG}\right)_{t-2} - \underset{(4.11)}{207.1} \left(\frac{PXG}{PWXG}\right)_{t-3}$$

$$- \underset{(4.14)}{358.1} \qquad - \underset{(4.14)}{313.3} \qquad - \underset{(4.14)}{268.5} \qquad - \underset{(4.14)}{223.8}$$

$$- \underset{(4.11)}{165.6} \left(\frac{PXG}{PWXG}\right)_{t-4} - \underset{(4.11)}{124.2} \left(\frac{PXG}{PWXG}\right)_{t-5} - \underset{(4.11)}{82.82} \left(\frac{PXG}{PWXG}\right)_{t-6} - \underset{(4.11)}{41.41} \left(\frac{PXG}{PWXG}\right)_{t-7}$$

$$- \underset{(4.14)}{179.0} \qquad - \underset{(4.14)}{134.3} \qquad - \underset{(4.14)}{89.51} \qquad - \underset{(4.14)}{44.76}$$

O.L.S. $\bar{R}^2 = 0.967$
SEE = 59.97
COV = 4.31
D/W = 1.33

T.S.F. $\bar{R}^2 = 0.967$
SEE = 60.05
COV = 4.33
D/W = 1.33

88. Exports of Services, 1Q52 - 4Q65

$$XS = \underset{(4.41)}{-107.8} - \underset{(8.22)}{97.33}\, Q1 - \underset{(1.58)}{18.66}\, Q2 + \underset{(10.41)}{123.2}\, Q3 + \underset{(22.95)}{487.9}\, AWS$$

O.L.S. $\bar{R}^2 = 0.942$
SEE = 31.31
COV = 7.47
D/W = 1.88

89. Real Domestic Product Less Agriculture

$$Y = \frac{YGNE + SUBS + INTF + DIVF - RES - TI - NRR - YFA + YX}{PGNE}$$

90. Assessed Taxable Income

$$YAS = -493.8 + 0.8153\ YP$$
$$\quad (6.81) \quad (71.99)$$

O.L.S. $\bar{R}^2 = 0.997$
SEE = 0.324
COV = 1.80
D/W = 1.52

91. Assessed Taxable Income between 0 and $3,000

$$YAS1 = Y1(YAS)$$

92. Assessed Taxable Income between $3,000 and $5,000

$$YAS2 = Y2(YAS)$$

93. Assessed Taxable Income between $5,000 and $10,000

$$YAS3 = Y3(YAS)$$

94. Assessed Taxable Income over $10,000

$$YAS4 = YAS - YAS1 - YAS2 - YAS3$$

95. Capacity Real Domestic Product

$$YC = 0.5\ \left(\frac{KME}{KMEY} + \frac{KNR}{KNRY}\right)$$

96. Disposable Personal Income

$$YD = YP - TP - TOP$$

97. Permanent Real Disposable Income

$$YDP = 0.176 \sum_{i=0}^{i=7} \cdot 9^{i} \left(\frac{YD}{PGNE}\right)_{t-i}$$

98. Gross National Expenditure

$$YGNE = YGPK(PGNE) + GW + GNW + MP + INVF - RES - GX$$

99. Private Non-farm Real Gross National Expenditure

$$YGPK = CND + CD + CS + IME + INRC + IRC + INV + XG + \frac{XS}{PXS} - MG - \frac{MS}{PMS}$$

100. Personal Income

$$YP = WSSL + MP - SSPS - UIR + YF + YNFC + YI + DIVC + GINT + CCB - TW - GIM + GTR + UIB + YRES$$

101. Simulated Income - Expenditure Residual

$$YRES = YGNE + DIVF - WSSL - MP - YI - YNFC - IVA - YFA - TI - CCA + SUBS - PC - RES$$

A P P E N D I X   C

LIST OF VARIABLES

APPENDIX C

LIST OF VARIABLES
(The 101 endogenous variables of the model are denoted by *)

	ALTM	Total assets (weighted) of trust and mortgage companies plus total assets less policy loans of twelve life insurance companies. Millions. (11240)
	ASST	Government capital assistance to industry. Millions. (11283)
	AWI	World activity index, 1957 = 1. (9863)
	AWS	World activity index for services, 1957 = 1. (8202)
*	AY	Personal income tax accruals. Millions. (11600)
	BCD	Chartered banks' Canadian dollar deposits at the Bank of Canada. Millions. (2795)
	BCN	Chartered banks' Canadian cash reserves, Bank of Canada notes. Millions. (399)
	CA	Chartered banks' capital account, shareholders' equity. Millions. (11208)
	CCA	Capital consumption allowances and miscellaneous valuation adjustments. Millions. (234)
	CCAC	Capital consumption allowances, corporations. Millions. (3711)
	CCB	Charitable contributions by corporations. Millions. (239)
*	CD	Personal expenditure on consumer durables. Millions of 1957 dollars. (141)
*	CFR	Cash flow ratio. The cash flow is the sum of corporate retained earnings (PCRT) and capital consumption allowances (CCAC) deflated by the implicit private GNE deflator (PGNE). CFR is the ratio of the cash flow to the trend value of the cash flow (CFRT). (11096)
*	CFRT	Trend value of the cash flow. (11310)
*	CL	Claimants on Unemployment Insurance Fund. Millions of persons. (11247)
*	CLC	Average cost of construction per square foot (including land) on new single detached NHA homes. (11369)
	CMHC	CMHC direct mortgage approvals. Millions. (11440)
*	CND	Personal expenditure on consumer non-durables. Millions of 1957 dollars. (140)
*	CS	Personal expenditure on consumer services. Millions of 1957 dollars. (139)
	D5	Dummy; equals 1 from first quarter 1952 to third quarter 1959, zero elsewhere. (11323)

D6 Dummy; equals 1 from fourth quarter 1959, zero elsewhere. (11324)

D7 Dummy; equals 1 from first quarter 1964, zero elsewhere. (11531)

D8 Dummy; equals 1 from first quarter 1961, zero elsewhere. (11459)

DCR Required cash reserve ratio. (11527)

* DD Chartered banks' demand deposits less float. Millions. (699)

DG Chartered banks' Government of Canada deposits. Millions. (386)

* DIVC Dividends paid to Canadians by Canadian companies. Millions. (2406)

* DIVF Dividends paid to non-residents by Canadian companies. Millions. (227)

DLK1 Dummy; equals 1 from third quarter 1963, zero elsewhere. (11108)

DLK4 Dummy; equals 1 in fourth quarter 1965, zero elsewhere. (11109)

DRS First difference of the Canadian price of U.S. dollars. Canadian dollars per U.S. dollar. (5691)

DRSF Defined as DRS from third quarter 1962, zero elsewhere. (11243)

DRSU Defined as DRS from third quarter 1961 to second quarter 1962, zero elsewhere. (11242)

DSK2 Dummy; equals 1 in each quarter of 1965, zero elsewhere. (11244)

DVST Dummy variable for sales tax on building materials; equals 1 from third quarter 1963 to second quarter 1966, zero elsewhere. (11027)

* ELA Chartered banks' more liquid assets (including foreign assets). Millions. (11296)

* EMPS Employed contributors to Unemployment Insurance Fund. Millions of persons. (11246)

ERL Chartered banks' excess legal reserves. Millions. (11297)

FLO Chartered banks' float, estimated net Canadian dollar items in transit. Millions. (11282)

* GBAL Total government national accounts surplus (if positive) or deficit (if negative). Millions. (1385)

GIM Total investment income, all levels of government. Millions. (1361)

	GINT	Interest on the public debt. Millions. (1375)
	GNW	Government nonwage expenditure. Millions. (11068)
	GTR	Government transfer payments to persons, excluding interest on the public debt and unemployment insurance benefits. Millions. (11287)
*	GW	Government wage payments, public administration. Millions. (11067)
	GWI	Government wage payments, institutional sector. Millions. (11379)
	GX	Correction for seasonality in quarterly series for government wage and non-wage expenditure. Millions. (11601)
*	H	Stock of non-farm inventories. Millions of 1957 dollars. (11636)
*	HAW	Average weekly hours worked by non-agricultural paid workers. (1205)
*	HAWT	Trend value of HAW. (11414)
	HH	Number of families in Canada. Thousands. (3054)
*	HSL	Inventory stock/sales ratio. (11637)
*	HSLT	Trend value of inventory stock/sales ratio. (11638)
*	HST	Total number of dwelling starts. Thousands. (3064)
*	IME	Investment in machinery and equipment. Millions of 1957 dollars. (11306)
*	INRC	Investment in non-residential construction. Millions of 1957 dollars. (11307)
*	INS	Average quarterly level of enrolment in Unemployment Insurance Fund. Millions of persons. (11257)
	INTF	Interest payments to non-residents. Millions. (11651)
*	INV	Change in non-farm business inventories. Millions of 1957 dollars. (150)
	INVF	Farm inventories and grain in commercial channels. Millions. (219)
*	IRC	Investment in new residential construction. Millions of 1957 dollars. (145)
	IVA	Inventory valuation adjustment. Millions. (231)
*	KME	Stock of machinery and equipment. Millions of 1957 dollars. (11309)
*	KMED	Desired stock of machinery and equipment. Millions of 1957 dollars. (11316)
*	KMEG	Gap between desired and actual stock of machinery and equipment. Millions of 1957 dollars. (11317)

*	KMEY	Trend value of machinery and equipment capital/output ratio. (11315)
*	KNR	Stock of non-residential construction. Millions of 1957 dollars. (11314)
*	KNRD	Desired stock of non-residential construction. Millions of 1957 dollars. (11313)
*	KNRG	Gap between desired and actual stock of non-residential structures. Millions of 1957 dollars. (11090)
*	KNRY	Trend value of non-residential construction capital/output ratio. (11311)
	L	Index of land costs on new single detached NHA homes. 1957 = 100. (11372)
*	LB	Chartered banks' business loans over $100,000. Millions. (11271)
	LBS	Chartered banks' business loans under $100,000. Millions. (11272)
	LF	Chartered banks' loans to instalment finance companies. Millions. (693)
	LH	Chartered banks' insured mortgages. Millions. (3993)
*	LINE	Estimated trend value of ln INRC. (11449)
*	LIRE	Estimated trend value of ln IRC. (11450)
	LM	Chartered banks' farm, CSB, grain dealer and institution loans. Millions. (11290)
	LMUN	Chartered banks loans to municipalities. Millions. (692)
*	LP	Chartered banks' loans to persons. Millions. (11042)
	LPRV	Chartered banks' loans to provinces. Millions. (691)
*	LTK	Net long-term capital inflow. Millions. (9143)
*	MG	Imports of goods. Millions of 1957 dollars. (9147)
	MLTM	Weighted sum of total mortgage holdings of trust, mortgage and twelve life insurance companies. Millions. (11645)
	MP	Military pay and allowances. Millions. (225)
*	MS	Imports of services. Millions. (9149)
	N03	Proportion of total persons taxable with taxable incomes between 0 and $3,000. (11302)
	N35	Proportion of total persons taxable with taxable incomes between $3,000 and $5,000. (11303)

N51 Proportion of total persons taxable with taxable incomes between $5,000 and $10,000. (11305)

N10 Proportion of total persons taxable with taxable incomes over $10,000. (11304)

* NEP Total number of paid workers. Millions of persons. (11064)

NEPG Paid workers, public administration and defense. Millions of persons. (11060)

* NEPP Paid workers, private sector. Millions of persons. (11059)

* NEUP Employed, unpaid workers. Millions of persons. (11062)

* NL Total civilian labour force. Millions of persons. (11141)

NRR Income received from non-residents. Millions. (11322)

* NT Total number of persons taxable, calculated. Millions of persons. (11544)

* NT03 Number of persons taxable with taxable incomes between 0 and $3,000, calculated. Millions of persons. (11545)

* NT35 Number of persons taxable with taxable incomes between $3,000 and $5,000, calculated. Millions of persons. (11546)

* NT51 Number of persons taxable with taxable incomes between $5,000 and $10,000, calculated. Millions of persons. (11547)

* NT10 Number of persons taxable with taxable incomes over $10,000. Millions of persons. (11548)

* NU Total unemployed. Millions of persons. (11063)

OCS Chartered banks' other Canadian securities. Millions. (3950)

OTHA Chartered banks' all other assets. Millions. (11209)

OTHL Chartered banks' all other liabilities. Millions. (11038)

* PC Corporation profits before taxes and before dividends paid to non-residents. Millions. (226)

* PCRT Undistributed corporation profits. Millions. (1393)

* PCT Taxable corporation profits. Millions. (11647)

* PD Implicit price index of consumer durable expenditure. 1957 = 1. (11384)

* PGNE Deflator of gross national expenditure, less government expenditure and less farm inventories. 1957 = 1. (9153)

* PH Index of housing prices. 1957 = 100. (11070)

	PLMT	Provincial logging and mining taxes. Millions. (11626)
	PMB	Net new issues of provincial and municipal securities. Millions. (11465)
	PMG	Implicit price index of goods imports. 1957 = 1. (9145)
	PMS	Implicit price index of services imports. 1957 = 1. (9151)
*	PND	Implicit price index of personal expenditure on consumer non-durables. 1957 = 1. (11423)
*	PNPS	Chartered banks' personal savings and non-personal term and notice deposits. Millions. (11644)
	POP	Civilian, non-institutional population. Millions of persons. (11308)
	POPT	Total Canadian population. Millions of persons. (3032)
	PWXG	Price index of world exports in Canadian dollars. 1957 = 1. (9154)
*	PXG	Implicit price index of goods exports. 1957 = 1. (9144)
*	PXS	Implicit price index of services exports. 1957 = 1. (9150)
	Q1	First-quarter seasonal dummy. 1 in first quarter, zero elsewhere. (11073)
	Q2	Second-quarter seasonal dummy. 1 in second quarter, zero elsewhere. (11074)
	Q3	Third-quarter seasonal dummy. 1 in third quarter, zero elsewhere. (11075)
	Q4	Fourth-quarter seasonal dummy. 1 in fourth quarter, zero elsewhere. (11076)
*	R03	Average yield on short-term Government of Canada bonds, zero to three years. (1365)
*	RC	Conventional mortgage rate. (1096)
	RDC	Rate of dividend tax credit. (11006)
	RES	Residual error of estimate. Millions. (235)
*	RLC	Average yield on long-term Government of Canada bonds, ten or more years to maturity. (2764)
*	RLCI	Twelve-quarter moving index of RLC. (11091)
	RLUS	U.S. corporation bond yield. (11466)
*	RM	Mortgage rate. (11318)

	RNHA	Maximum NHA mortgage rate. (245)
	RPC	Weighted marginal rate of corporation income tax. (11007)
	RPR	Chartered banks' prime loan rate. (397)
	RSC	Sales tax rate on consumption goods. (11025)
	RSIM	Sales tax rate on machinery and equipment. (11620)
	RSIR	Sales tax rate on non-residential construction. (11621)
*	RSR	Change in official foreign exchange reserves. Millions of Canadian dollars. (11289)
	RTUS	Market yield on U.S. Government three-month bills. (4255)
	RW1	Weighted tax rate for 0 to $3,000 class. (11019)
	RW2	Weighted tax rate for $3,000 to $5,000 class. (11020)
	RW3	Weighted tax rate for $5,000 to $10,000 class. (11021)
	RW4	Weighted tax rate for over $10,000 class. (11022)
	S	Dummy; equals 1 from first quarter 1959 to fourth quarter 1967, zero elsewhere. (11327)
	S2	Four-quarter moving variance of holding period yield on five-year rate. (2702)
	SP	Number of persons going to school. Millions of persons. (11396)
	SSPS	Social security and pension contributions net of employer and employee payments into Unemployment Insurance Fund. (11285)
*	STH	Stock of houses. Thousands of units. (3057)
*	STK	Net private short-term capital inflow. Millions. (9139)
	SUBS	Total subsidies from all levels of government. Millions. (1378)
	SUR	Amount of surcharge that would have been collected had the 1961 volume of goods imports been maintained through the surcharge period, second quarter 1962 to fourth quarter 1963. (11010)
	T	Time trend, equals 1 in first quarter 1947. (11142)
	T1	Time trend; equals 6 in first quarter 1952 increasing to third quarter 1959, zero elsewhere. (11325)
	T2	Time trend; equals 1 in first quarter 1959 increasing to fourth quarter 1967, zero elsewhere. (11326)

	T3	Time trend; a step function, equals 1 in each quarter of 1950, 2 in 1951, etc. (11625)
*	TA	Chartered banks' total business loan authorizations outstanding over $100,000. Millions. (11273)
*	TBA	Chartered banks' total major assets. Millions. (383)
*	TBAT	Time trend of chartered banks' total major assets. Millions. (11572)
*	TCA	Corporation income tax accruals. Millions. (1352)
*	TCUS	Customs import duties. Millions. (2157)
*	TD	Chartered banks' total Canadian deposits including government deposits. Millions. (384)
*	TEX	Excise duties. Millions. (2158)
*	TI	Total indirect taxes. Millions. (1358)
*	TL	Chartered banks' total loans. Millions. (11291)
	TMIS	Indirect taxes other than the federal sales tax, and customs and excise duties. Millions. (11288)
	TOP	Total personal direct taxes other than personal income taxes. Millions. (11321)
*	TP	Personal income tax collections. Millions. (11560)
*	TS	Federal sales tax collections. Millions. (11270)
	TW	Federal withholding taxes. Millions. (1357)
*	UIB	Federal transfers to persons, unemployment insurance benefits. Millions. (2167)
*	UIR	Employer and employee contributions to Unemployment Insurance Fund. Millions. (2178)
*	ULC	Unit labour costs in the private sector. (11649)
	VC	Bank of Canada notes at chartered banks. Millions. (389)
	WC	Average hourly earnings of hourly rated construction workers. (2486)
	WG	Average quarterly wage in the government sector. (11057)
*	WP	Average quarterly wage in the private sector. (11056)

*	WPH	Average hourly wage in the private sector. (11425)
	WR	Weighted maximum rate of unemployment insurance payments. (11248)
*	WSSL	Wages, salaries and supplementary labour income. Millions. (224)
	WW	Dummy winter works variable; equals 1 in fourth quarter 1963 and each fourth quarter thereafter, zero elsewhere. (11320)
*	XG	Exports of goods. Millions of 1957 dollars. (9146)
*	XS	Exports of services. Millions. (9148)
*	Y	Real domestic product less agriculture. Millions of 1957 dollars. (11312)
	Y1	Proportion of total assessed income in 0 to $3,000 class. (11393)
	Y2	Proportion of total assessed income in $3,000 to $5,000 class. (11394)
	Y3	Proportion of total assessed income in $5,000 to $10,000 class. (11395)
	Y4	Proportion of total assessed income in over $10,000 class. (11398)
*	YAS	Total assessed income, calculated. Millions. (11550)
*	YAS1	Total assessed income in 0 to $3,000 class. Millions. (11551)
*	YAS2	Total assessed income in $3,000 to $5,000 class. Millions. (11552)
*	YAS3	Total assessed income in $5,000 to $10,000 class. Millions. (11553)
*	YAS4	Total assessed income in over $10,000 class. Millions. (11554)
*	YC	Capacity real domestic product less agriculture. Millions of 1957 dollars. (11446)
*	YD	Personal disposable income. Millions. (1398)
*	YDP	Permanent real disposable income. Millions of 1957 dollars. (3052)
	YEX1	Average exemptions claimed by taxpayers with assessed incomes between 0 and $3,000. Dollars. (11556)
	YEX2	Average exemptions claimed by taxpayers with assessed incomes between $3,000 and $5,000. Dollars. (11557)
	YEX3	Average exemptions claimed by taxpayers with assessed incomes between $5,000 and $10,000. Dollars. (11558)
	YEX4	Average exemptions claimed by taxpayers with assessed incomes over $10,000. Dollars. (11559)

	YF	Income of farm operators excluding accruals. Millions. (11005)
	YFA	Accrued net income of farm operators from farm production. Millions. (229)
*	YGNE	Gross national expenditure at market prices. Millions. (223)
*	YGPK	Gross national expenditure less government expenditure and less farm inventories. Millions of 1957 dollars. (11069)
	YI	Rent, interest and miscellaneous investment income. Millions. (228)
	YNFC	Net income of non-farm unincorporated business. Millions. (230)
*	YP	Personal income. Millions. (240)
*	YRES	Simulation residual; defined to be zero over estimation period but equilibrating income and expenditure sides of national accounts under simulation. (11528)
	YX	Real domestic product less agriculture residual; defined to reconcile the national accounts definition with the figures published by the Dominion Bureau of Statistics in index form. Millions. (11650)

APPENDIX D

The Compleat RDX1

This flow chart, "The Compleat RDX1" (Chart 10), prepared by André Lemelin, provides the most compact description of the causal structure of RDX1. Every equation of the model is represented by a box. Each such box contains in the upper right part the number of the equation and the abbreviation for the name of the dependent variable explained by the equation. In the lower right part of each box are listed the names of the independent variables in that equation. In the left part of the box are listed the numbers of the equations into which the dependent variable enters as an independent variable. Arrows trace the routes of influence from each box to each other equation where that dependent variable appears as an independent variable. The one exception is provided by the basic price variable, PGNE, whose influences are so pervasive that they do not permit individual lines to be easily drawn. Therefore a line has been placed across the top of the chart originating at the box for the PGNE equation. This line contains a series of black triangles above the various equations that PGNE enters as an explanatory variable.

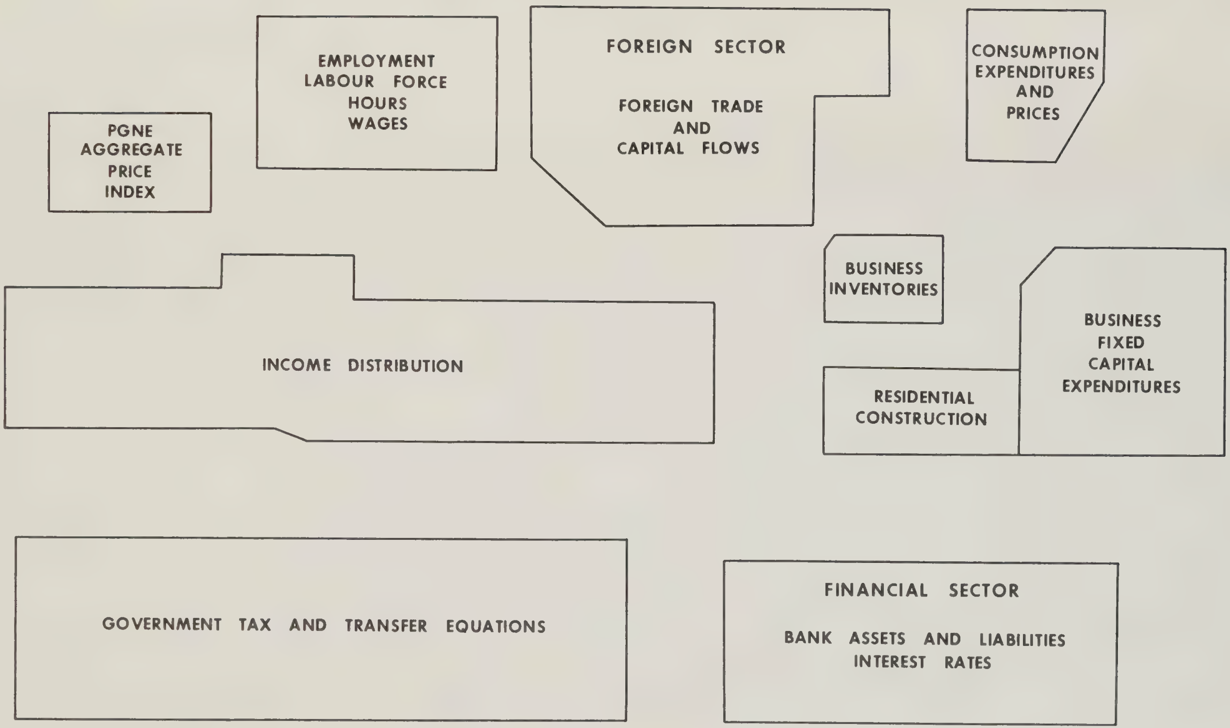
The schematic chart (Chart 9) on page 79 has labels for the sectors of RDX1 as they are laid out in the flow chart. In the larger chart (Chart 10) heavy black lines enclose the various sectors labelled in the smaller chart (Chart 9).

Chart 10 is worth some study, for it is the most convenient source of information about the causal structure of RDX1. Appendix B does give additional information about the nature and magnitude of the effects acting directly in each equation, but there is no way of telling how the dependent variable in each equation plays a role, in its turn, in other equations of the model. The flow chart does this for us by means of the arrows and also by means of the lists of equation numbers in the left part of each equation box.

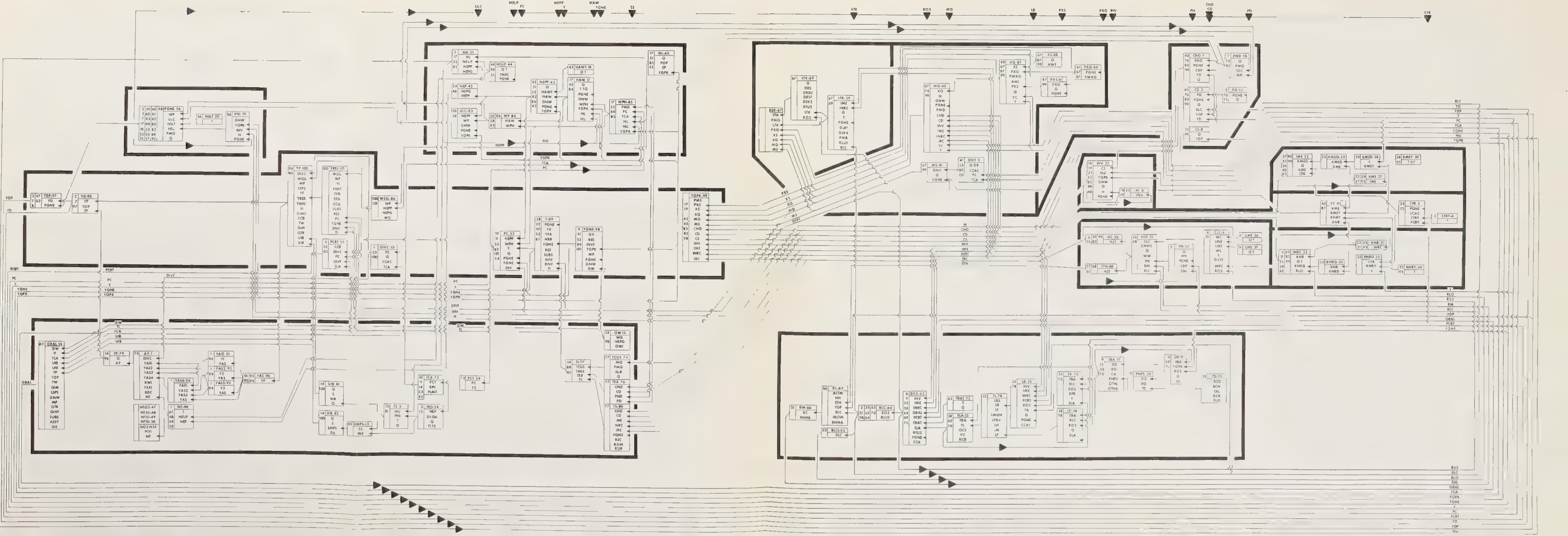
One thing that the flow chart will not do is reveal anything about the dynamic behaviour of RDX1, except to indicate where the lagged value of a variable appears in its own equation. Since most of the lags in RDX1 are polynomial distributions involving several past periods, the dynamic behaviour of the whole system is too complicated to be captured in a flow chart. An understanding of the flow chart is thus only a first step towards an understanding of the dynamics of RDX1.

Chart 9

MAJOR SECTORS OF THE COMPLEAT RDX1



THE COMPLEAT RDX1



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HOUSING AND MORTGAGE MARKETS IN CANADA

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LAWRENCE B. SMITH

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HOUSING AND MORTGAGE MARKETS IN CANADA

Lawrence B. Smith

This paper is a report on the research underlying the housing and mortgage market equations used in RDX1, the experimental aggregate model of the Canadian economy developed in the Research Department of the Bank of Canada. The views expressed are the personal views of the author and no responsibility for them should be attributed to the Bank.

The Bank of Canada Staff Research Studies are produced by an offset process. The type style is Adjutant. Charts are prepared in the Graphics Section of the Research Department under the direction of Carl E. Strike. The typist is Cheryl J.M. Runnells. The studies are prepared under the editorial direction of Margaret A. Bailey.

PREFACE

In this study an attempt is made to specify and analyze the structure of, and the forces operating on, housing and mortgage markets in Canada. The structure thus developed is then used to examine the implications of alternative government policies for housing and mortgage lending.

I begin the study by examining the determinants of residential construction expenditure, total housing starts, the stock of housing, housing prices, construction costs, land costs, mortgage interest rates and the volume of mortgage lending undertaken by financial institutions. Housing starts, which play a pivotal role in the housing and mortgage market model, are found to be strongly influenced by the cost and availability of private and government mortgage credit, and also by the relationship between housing prices and construction and land costs. Housing prices are shown to depend upon the existing per family stock of housing, per family real disposable income and the price of alternative goods and services. Construction costs are found to be influenced by land costs, financing costs and labour costs, and by the relationship between the volume of current construction and industrial capacity. The mortgage rate, which is important both as the cost of mortgage credit and as an influence on the availability of mortgage credit, is determined by the interaction of the demand for, and the supply of, mortgage finance.

Often substantial information about the housing market is lost when it is treated on a highly aggregative level. Because the housing sector of RDX1 is based upon aggregative data, a second, more disaggregative housing model was developed in which the single and multiple dwelling segments of the market were treated individually. Several basic differences in the behaviour of these segments were found. The two most important of these differences are, first, the more restrictive effect credit rationing has on the volume of single dwelling construction compared to multiple dwelling construction (although both segments were quite

responsive to variations in the cost of mortgage credit), and, second, the opposite effect rising land costs have on both these segments, since rising land costs shift the composition of construction in favour of multiple construction.

Because mortgage credit and mortgage interest rates are so important to the housing market, mortgage investment behaviour of the major financial institutions engaged in the mortgage market and determinants of the inflows of funds into these institutions are examined in some detail. Not surprisingly, preliminary evidence indicates that these financial flows are quite sensitive to alternative interest yields.

Finally, in order to assess the implications of changes in monetary and selective credit policies for the housing market, alternative policy simulations were run. The policies simulated were changes in: the government bond rate, the National Housing Act interest ceiling, and the volume of Central Mortgage and Housing Corporation direct lending.

I wish to thank Professor G.R. Sparks for his valuable comments on this study, and Dr. Ian Stewart and Miss Lynne Orman for their very great computational assistance in its preparation.

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PRÉFACE

Dans cette étude, nous essayons de définir et d'analyser la structure du marché du logement et du crédit hypothécaire au Canada, et les facteurs qui l'affectent. La structure ainsi obtenue sert ensuite à montrer les répercussions possibles des différentes politiques adoptées par les pouvoirs publics en matière de logement et de crédit hypothécaire.

Au début de l'étude nous commençons par définir les facteurs qui conditionnent les divers éléments de ce secteur tels que: dépenses pour la construction d'habitations, total des mises en chantier de logements, total des unités de logement disponibles, prix des logements, coût de la construction, prix des terrains, taux d'intérêt des prêts hypothécaires et total des prêts de ce genre consentis par les institutions financières. Nous constatons que les mises en chantier de logements, qui jouent un rôle capital dans le modèle du marché du logement et du crédit hypothécaire, sont fortement influencées par le coût du crédit, d'origine privée ou publique, et les possibilités de l'obtenir, ainsi que par le rapport entre le prix des habitations et celui des terrains et de la construction. Les prix des logements sont définis comme étant fonction du nombre d'unités de logements existants par rapport au nombre de ménages et du revenu réel disponible par ménage ainsi que du prix des autres biens et services. Nous constatons que le coût de la construction est influencé par le prix des terrains, le coût du financement et celui de la main-d'oeuvre, et par le rapport entre le volume de la construction en cours et la capacité totale du secteur du bâtiment. Le taux d'intérêt des prêts hypothécaires, qui est important à la fois par son influence sur le prix du crédit et sur la possibilité de l'obtenir, est fixé par le jeu de l'offre et de la demande de financement.

On perd souvent une quantité considérable de renseignements sur le marché du logement lorsque l'étude en est faite de manière très sommaire. Comme le secteur du logement du modèle RDX1 avait été établi sur la base de données d'ensemble, nous avons construit un autre modèle détaillé pour le logement dans lequel les données

relatives aux maisons unifamiliales et celles concernant les constructions multifamiliales ont été traitées séparément. Nous avons constaté des différences profondes de comportement dans ces deux sections. Parmi ces différences, les deux plus importantes sont: tout d'abord, l'effet plus restrictif produit par le rationnement du crédit sur la construction de maisons unifamiliales que sur les constructions comportant plusieurs logements (bien que les deux sortes d'habitations aient réagi promptement aux variations du coût du crédit immobilier) et, en second lieu, l'effet défavorable de l'augmentation du prix des terrains sur les deux sortes de constructions puisque cette augmentation a pour effet de pousser à la construction d'un plus grand nombre de logements multiples.

Etant donné l'importance particulière du crédit hypothécaire et les taux d'intérêt des prêts hypothécaires pour le marché du logement, nous avons étudié en détail l'évolution des investissements réalisés sur le marché hypothécaire par les principaux établissements financiers qui s'y intéressent et les facteurs qui déterminent le mouvement des fonds vers ces établissements. On n'est pas surpris de constater d'emblée l'extrême sensibilité de ces mouvements de fonds aux divers taux de rendement.

Enfin, pour nous permettre d'évaluer les répercussions possibles des modifications apportées aux politiques monétaires et de crédit sélectif sur le marché du logement, nous avons effectué des simulations de politique. Celles-ci comportaient des modifications aux taux d'intérêt des fonds d'Etat, au plafond de l'intérêt fixé par la Loi nationale sur l'habitation et au volume global des crédits accordés par la Société Centrale d'Hypothèque et de Logement.

Je tiens à remercier M. le Professeur G.R. Sparks pour ses commentaires très utiles sur la présente étude, ainsi que M. Ian Stewart et Mlle Lynne Orman pour la précieuse assistance qu'ils m'ont fournie par leur traitement de l'information.

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INTRODUCTION

Residential construction plays a vital role in the Canadian economy. Providing employment for 5 per cent of the labour force ([8], p. 29 and [17], p. 258), accounting directly for 40 per cent of total new construction, 25 per cent of business gross fixed capital formation, and 4.5 per cent of gross national product (GNP),[1] residential construction also influences indirectly the demand for consumer durables and residential service investment. In addition to its pervasiveness, residential construction is the mechanism for providing more and better housing and is extremely sensitive, with a short response lag, to changes in general economic conditions. Consequently this sector is extremely important for both social and general economic stabilization purposes. Since over 80 per cent of the financing for new residential construction comes from the mortgage market and just under 80 per cent of all mortgage credit goes into housing,[2] the housing and mortgage markets are inexorably intertwined and should be examined together. The purpose of this paper is to discuss in some detail the derivation, structure and implications of the housing and mortgage sectors of RDX1 [24], the experimental econometric model of the Canadian economy developed in the Research Department of the Bank of Canada. In addition, a somewhat more elaborate and sophisticated model, which can be incorporated into the RDX model, is described and discussed.

The paper is divided into six sections and two appendices. In the first section the general structure of a model of the housing and mortgage market is briefly outlined. The RDX1 housing and mortgage market equations are derived and estimated statistically in the second section. Some of the structural relationships underlying the RDX1 mortgage equations are examined in the third section, and the mortgage sector of RDX1 is extended. A disaggregation of the housing sector of RDX1 and the extension of a number of relationships presently combined in that sector are

[1]These figures are based upon the 1948-1967 period.

[2]These percentages were calculated for the 1960-1967 period.

presented in the fourth section. In the fifth section a summary is provided of the functional and statistical relationships developed in the preceding four sections. In the sixth section the existing RDX1 and extended housing and mortgage sectors are simulated, and the impact of alternative policies on the housing market is examined. Two-stage estimates of the basic RDX1 housing model are presented in Appendix A, and estimates updated to the end of 1967 of the basic RDX1 and extended housing models in Appendix B.

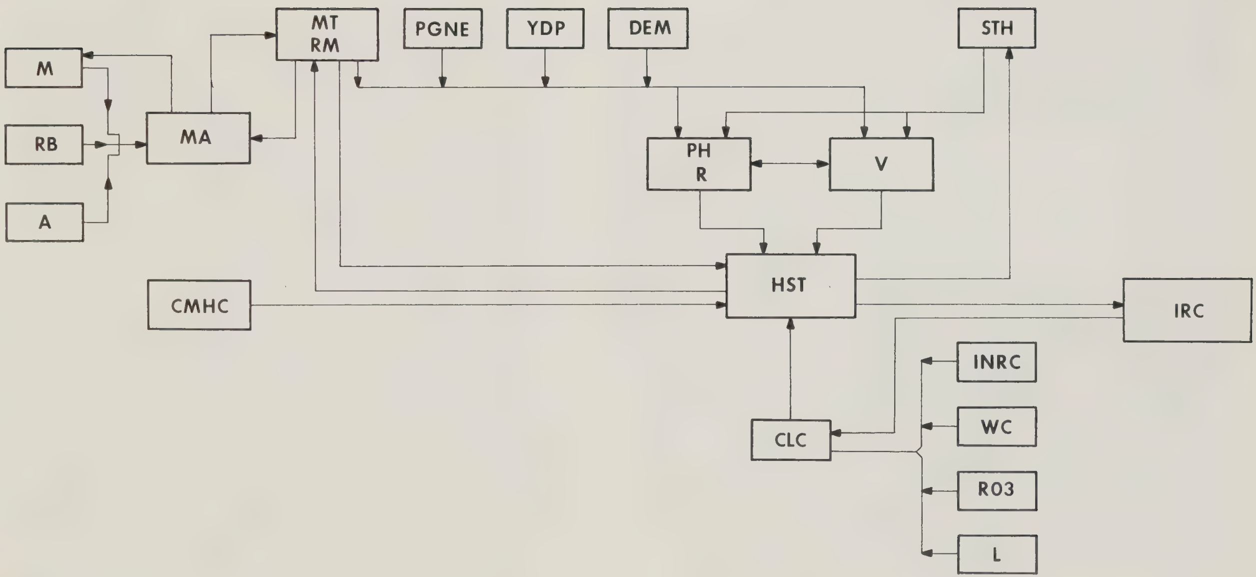
1. THE GENERAL STRUCTURE OF THE MODEL

The general structure of the housing and mortgage market model is presented in flow chart form in Diagram 1, and essentially follows a stock-flow approach.[3] On the right side of the diagram and moving left, residential construction expenditure (IRC) is a function of current and lagged housing starts (HST). The volume of housing starts undertaken in any period depends upon a comparison of housing prices (PH), rent (R), and vacancy rates (V) with construction and land costs (CLC), and financing costs (RM), and upon the availability of public Central Mortgage and Housing Corporation direct lending (CMHC) and private (MT) mortgage credit. Prices and vacancy rates are determined by the price of alternative goods and services (PGNE), permanent real disposable income (YDP), demographic factors (DEM), and the cost and availability of mortgage credit. The current supply of housing units (STH) depends upon the previous supply of housing units and lagged housing starts. Construction costs depend upon the average hourly earnings of labour in the construction industry (WC), the cost of temporary or bridge financing (R03), and the current level of residential (IRC) and non-residential (INRC) construction relative to their respective industrial capacities. Land costs (L) are determined primarily by the demand for residential land. This demand is represented by demographic variables, permanent real disposable income, and the existing stock of housing units, although this relationship is not shown in the flow diagram.

[3]Much of the work in sections 1 and 2 is based upon an earlier paper by the author [44].

Diagram 1

FLOW CHART OF HOUSING AND MORTGAGE MARKETS



On the left side of the diagram, the availability of public mortgage credit, which arises via Central Mortgage and Housing Corporation (CMHC), is a policy variable, while the cost (RM) and other lending terms (MT) of private mortgage credit depend upon the demand for and supply of this credit. The demand for mortgage credit depends essentially upon the same factors as the demand for houses and the cost of alternative sources of funds; while the supply of mortgage credit, or institutional mortgage approvals (MA), depends upon the yield and other attributes of mortgage investments relative to those obtainable on alternative security investments (RB), the size of institutional investment portfolios (A), and the size of their existing mortgage holdings (M). The size of an institution's investment portfolio is taken to depend upon the yield paid on the institution's liabilities relative to the yield on alternative market securities, the public's wealth and the public's existing holdings of the institution's liabilities, although this relationship is not shown in the flow chart.

2. THE HOUSING AND MORTGAGE SECTORS OF THE BANK OF CANADA MODEL, RDX1[4]

Because of the general complexity of multi-sector models, such as the Bank of Canada model, RDX1, for purposes of manipulation and comprehension it is desirable to aggregate and simplify individual sectors whenever possible. Consequently, although some structural and institutional features were blurred, I substantially simplified the structure of the housing and mortgage market sectors. This was accomplished by making the usual heroic assumptions that the behaviour of the participants in the single and multiple dwelling subsectors of the housing market are similar and that prices, rents, vacancy rates and construction costs in these subsectors vary proportionately, thereby justifying an aggregative treatment of the housing market.[5] In addition, the

[4]The estimated results presented in this section differ slightly from those presented in RDX1 [24] because of data revisions, slight specification changes, and the use of the RB interest rate variable rather than RLC.

[5]For examples of other aggregative models see: [21], [23], [30], [31], [32], [33], [35] and [49].

mortgage market was reduced to a single interest rate determination equation. In the sections that follow, these assumptions and constraints are relaxed and a more comprehensive mortgage sector and a more disaggregated housing sector are presented.

A. *Residential Construction Expenditure and Housing Starts*

The approach followed in this study is to focus attention on the operation of the housing market so that one could ultimately determine the volume of housing starts undertaken in any period. The linkage between the housing market and the *National Accounts*[6] is then made by converting housing starts to constant-dollar residential construction expenditure.

Residential construction expenditure, defined as the expenditures of business and persons on new residences, including garages and major alterations to existing dwellings, is estimated by the Dominion Bureau of Statistics (D.B.S.) according to a complicated formula centering on the number of physical units put in place during any period.[7] Since the number of physical units put in

[6] *National Accounts, Income and Expenditure* issued quarterly and annually by the Dominion Bureau of Statistics, catalogue nos. 13-001 and 13-201, respectively.

[7] The basic formula (later revised) used by D.B.S. during the estimation period is that residential construction expenditure (IRC) equals the sum of the value of residential construction put in place (VPP), major alteration expenditures (ALT), and supplementary costs (SUP).

$$IRC = VPP + ALT + SUP$$

VPP is based upon physical units put in place (PP) converted to value terms by weighting single dwellings, multiple dwellings and conversions (superscript s, m and c, respectively) put in place by their respective average unit values in 1956, updated by the composite construction cost index (CCC). (The index used to update the average value of conversions differs slightly from that used to update single and multiple dwellings by weighting wages more heavily than in the adjustment for single and multiple dwellings.) If X, Y, and Z are the average unit values of the base year for single dwellings, multiple dwellings and conversions, respectively, and if CCC is the composite construction cost index in the current period with CCC = 100 in the base year for X, Y and Z, then

$$VPP = CCC\ [X(PP^{s}) + Y(PP^{m}) + Z(PP^{c})]$$

(contd on p. 6.)

place is estimated from a compilation of the number of dwelling units started, under construction, and completed during a period without making allowance for possible changes in the average quality of a physical unit,[8] and since the number of units under construction and completed during any period is a function of past housing starts, I specified residential construction expenditure (IRC) as a function of current and lagged housing starts (HST).

$$IRC = f\left(\sum_{i=0}^{m} \beta_i \, HST_{t-i}\right) \qquad (1)$$

A preliminary estimate of this relationship using quarterly 1954-1965 data is presented in equation (2), where bracketed values are t values, SEE is the standard error of estimate and D/W is the Durbin/Watson statistic.[9] This regression indicates that lagged housing starts provide a reasonable approximation of resi-

1Q54-4Q65

$$\underset{(6.62)}{IRC = 117.15} + \underset{(16.96)}{4.62\, HST} + \underset{(7.69)}{1.96\, HST_{t-1}} + \underset{(3.32)}{.92\, HST_{t-2}} \qquad (2)$$

$$SEE = 22.06 \qquad R^2 = .89 \qquad D/W = 1.05$$

The PP for each category are estimated from the number of units in each category (started (S), under construction (U) and completed (C)) during the period according to the formula PP = .94 [1/3 S + 1/3 C + 1/6 U]. Hence,

$$VPP = .94\,[X(1/3\, S^s + 1/3\, C^s + 1/6\, U^s) + Y(1/3\, S^m + 1/3\, C^m + 1/6\, U^m)$$
$$+ Z(1/3\, S^c + 1/3\, C^c + 1/3\, U^c)]\ CCC$$

Major alterations are estimated from building permits issued and tend to be relatively constant from $20 million to $25 million quarterly.

$$SUP = .024\, VPP^s + .072\, VPP^m$$

Therefore, if ALT is considered to be a constant over the estimation period, and if C and U are considered to be functions of past housing starts, then IRC in constant dollars can be considered to be a function of housing starts.

[8]Except to the extent that shifts occur in the mix of single and multiple dwelling construction, since these categories have different weights.

[9]Estimation procedures and problems are discussed in more detail below.

dential construction expenditure, that the contribution of past housing starts declines with time, and that a housing start generates an average expenditure of $7,510 in constant 1957 dollars. Unfortunately, the Durbin/Watson statistic indicates that the residuals in this regression are serially correlated [16], and therefore an autoregressive transformation using a procedure suggested by Hildreth and Lu [26] was performed. This procedure assumes that the residuals (u) in my regression are generated by a first-order autoregressive scheme

$$u = \rho\, u_{t-1} + \varepsilon$$

and attempts to select the ρ that minimizes the residual variance of the specified equation. In the work that follows, whenever serial correlation is indicated by the Durbin/Watson statistic or is undetectable because of the inclusion of a lagged dependent variable in a regression [34], an autoregressive transformation will be conducted. The transformed regression and value of the autoregressive parameter are presented below the untransformed regression whenever the autoregressive parameter ρ lies outside the range -.1 to .1 (i.e., whenever $|\rho| > .1$).

The transformed regression of residential construction expenditure is presented in equation (2') and substantiates my previous findings except that the average residential construction expend-

$$\underset{}{IRC} = \underset{(4.67)}{86.27} + \underset{(22.45)}{5.02}\ HST + \underset{(9.88)}{2.13}\ HST_{t-1} + \underset{(5.32)}{1.19}\ HST_{t-2} \qquad (2')$$

$$SEE = 19.18 \qquad \rho = .538 \qquad D/W = 2.27$$

iture generated by a housing start in constant 1957 dollars has increased to a more reasonable $8,340.

Turning now to a discussion of housing starts, it is useful at the outset to distinguish between builders or developers of housing projects and the final demanders of housing units. Builders and developers are of course the entrepreneurial group engaged in the construction of new residential dwellings while the final demanders are the tenants in rental units and owners in owner-occupied dwellings. When the net user demand for dwelling units in either form increases, the number of vacant dwellings declines

and pressure is placed on housing prices and rents. Assuming that these variations are not immediately reflected in construction and land costs, rising prices and rents increase the likelihood that new construction projects will be profitable and, hence, lead to an increase in construction activity.

In addition to prices, rents, vacancy rates and construction costs, the volume of building undertaken depends upon the cost and availability of mortgage credit (see [1], [3], [23], and [47]). Higher interest costs and less favourable non-price borrowing terms (lower appraisal values, lower loan-to-value ratios, shorter amortization periods) reduce the desirability and feasibility of rental construction projects by increasing equity requirements and reducing net cash flows. More stringent borrowing terms also discourage construction of owner-occupancy dwellings by making monthly carrying costs and downpayment requirements more difficult for prospective purchasers to absorb.

If one assumes that prices and rents on owner-occupancy and rental dwellings vary proportionately, the volume of new housing starts (HST) may be summarized as a function of the price of houses (PH), the vacancy rate (V), construction and land costs (CLC), and the cost (RM) and availability of private (MT) and public (CMHC) mortgage credit.

$$HST = h\ (PH,\ V,\ CLC,\ RM,\ MT,\ CMHC) \qquad (3)$$

Before this model can be estimated some slight modifications are required in its specification because of data limitations and institutional considerations. These modifications consist of: the deletion of the vacancy variable from the model, the substitution of a proxy credit rationing variable (the yield differential between mortgages and bonds (RM - RB)) for non-price mortgage lending terms to represent the availability of private mortgage credit, and the introduction of a dummy variable (WW) (taking the value 1 in the last quarters of 1963 to 1965 and zero elsewhere) to represent the impact of the government winter house-building incentive programme.

The deletion of the vacancy variable, necessary because a meaningful measure does not exist in Canada,[10] implies that the housing price variable fully represents housing market conditions. Although this is a substantial simplification, serious bias does not arise in the model as long as prices are reasonably good indicators of market conditions. The mortgage to bond yield differential was used to represent private credit rationing effects since the supply of mortgage credit from private financial institutions appears to be quite sensitive to this differential ([43], [48], [51], and section 3 of this paper, p. 33), and since satisfactory loan-to-value ratio data and amortization-term data are not available.[11] Finally, the winter house-building incentive dummy variable was required because of a government programme between 1963 and 1965 that provided a $500 per dwelling subsidy for one- to four-unit dwellings substantially constructed between December 1 and March 31.

The validity of my specification was initially tested by fitting ordinary and two-stage least squares regressions to quarterly data over the 1954-1965 period. The ordinary least squares results are presented in the text and the two-stage least squares estimates,[12] which are very similar to the ordinary least squares estimates, are presented in Appendix A. The equations in my basic model and the extended housing sector were then reestimated over the longer 1954-1967 period and these ordinary least squares results are presented in Appendix B. In order to utilize all the available information and because some statistical series are not available as early as 1954, the estimation period was varied somewhat between regressions with each regression beginning in the first quarter in which data were available after 1954. The esti-

[10]In addition to the unavailability of this variable there are some theoretical reasons for deleting vacancies when constructing a national model. The basic problem may be seen by assuming internal migration from rural to urban areas. If the migrating family abandons, even temporarily, its rural dwelling and 'doubles up' in an urban area, there is an increase in housing demand (since the migrating family now demands a dwelling of its own in an urban area) and an increase in vacancies (in rural areas). An increase in vacancies therefore does not necessarily indicate a lessening of unsatisfied housing demand.

[11]For a further justification of this specification see [23], pp. 275-298.

[12]When making the two-stage estimates I used instrumental variables created for the Bank of Canada model of the Canadian economy, RDX1 [24].

mation period, t ratios, R^2, standard error of estimate and Durbin/Watson statistic are reported for all regressions.[13] In addition, an R^2 adjusted for seasonality, $\bar{\bar{R}}^2$, is presented when appropriate.[14] Q1, Q2 and Q3 are first, second and third quarter seasonal dummy variables, respectively. The estimated housing start regression in untransformed and transformed form is shown in equations (4) and (4').

1Q57-4Q65

$$\begin{aligned}
HST = {} & \underset{(1.06)}{25.6} - \underset{(9.26)}{20.2}\ Q1 + \underset{(3.86)}{7.7}\ Q2 + \underset{(4.13)}{7.7}\ Q3 + \underset{(2.76)}{9.5}\ WW \\
& + \underset{(3.75)}{76.80}\ (PH/CLC) - \underset{(4.32)}{12.58}\ RM_{t-1} + \underset{(2.35)}{5.20}\ (RM - RB)_{t-1} \\
& + \underset{(1.44)}{.029}\ \left(\frac{CMHC}{PH}\right) + \underset{(3.93)}{.058}\ \left(\frac{CMHC}{PH}\right)_{t-1} \qquad (4)
\end{aligned}$$

SEE = 3.31 $\qquad R^2 = .95 \qquad \bar{\bar{R}}^2 = .82 \qquad$ D/W = 1.95

$$\begin{aligned}
HST = {} & \underset{(1.75)}{55.6} - \underset{(10.97)}{20.6}\ Q1 + \underset{(3.28)}{6.4}\ Q2 + \underset{(4.01)}{6.8}\ Q3 + \underset{(3.07)}{10.0}\ WW \\
& + \underset{(2.86)}{71.64}\ (PH/CLC) - \underset{(4.03)}{15.96}\ RM_{t-1} + \underset{(2.02)}{5.41}\ (RM - RB)_{t-1} \\
& + \underset{(.81)}{.017}\ \left(\frac{CMHC}{PH}\right) + \underset{(3.03)}{.044}\ \left(\frac{CMHC}{PH}\right)_{t-1} \qquad (4')
\end{aligned}$$

SEE = 3.23 $\qquad \rho = .295 \qquad$ D/W = 2.43

[13] The R^2 is not presented for the transformed regressions, but the explanatory power of these regressions may be seen by comparing the SEE of the transformed regression to its corresponding untransformed regression.

[14] $\bar{\bar{R}}^2 = \dfrac{RSS_1 - RSS_2}{RSS_1}$ where RSS_1 is the residual sum of squares associated with a regression of the dependent variable upon the intercept, Q1, Q2 and Q3, and RSS_2 is the residual sum of squares associated with the final regression.

The regressions in equations (4) and (4') tend to confirm the appropriateness of my specification since the volume of housing starts is significantly influenced by the ratio of housing prices to construction and land costs,[15] the availability of private mortgage credit (represented by the mortgage to bond yield differential (RM - RB)), the availability of public mortgage credit (taken as the constant-dollar volume of CMHC direct lending $(\frac{CMHC}{PH})$), and the cost (RM) of mortgage credit. The sum of the coefficients on the CMHC variable indicates that an additional million dollars of Central Mortgage and Housing Corporation direct lending in constant 1957 dollars will generate between 61 (the sum of the transformed coefficients) and 87 (the sum of the untransformed coefficients) additional housing starts.[16] Finally, the coefficient on the winter house-building incentive dummy variable (WW) indicates that this programme was quite successful in breaking the usual fourth-quarter decline in housing starts.

[15]Since I wrote this paper I have discovered that my profitability variable PH/CLC also reflects variations in the average size of new dwellings. This occurs because the PNHA component of the PH variable is based upon substantially the same data as the CLC variable, and is expressed on a per dwelling basis while CLC is expressed on a per square foot basis. However, the elimination of this influence does not affect any of the parameter estimates in the model. As an illustration, the housing start regression, where the problem is potentially most severe, is presented below over the longer estimation period 1Q57-4Q67 with PMLS/CLC replacing PH/CLC.

1Q57-4Q67

$$\underset{(1.65)}{HST = 29.7} \underset{(7.55)}{- 17.5\, Q1} \underset{(4.48)}{+ 10.1\, Q2} \underset{(3.88)}{+ 8.4\, Q3} \underset{(3.42)}{+ 9.5\, WW} \underset{(2.76)}{+ 67.49} (PMLS/CLC)$$

$$\underset{(3.71)}{- 12.12\, RM_{t-1}} \underset{(1.67)}{+ 3.87\, (RM - RB)_{t-1}} \underset{(2.85)}{+ .038} \left(\frac{CMHC}{PH}\right) \underset{(3.41)}{+ .044} \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 4.22 $\quad R^2 = .91 \quad$ D/W = 1.44

[16]This implies an average Central Mortgage and Housing Corporation mortgage loan of between $11,400 and $16,400 per unit in constant 1957 dollars was required to generate an additional housing start. This compares with the actual average current-dollar loan of $11,800 per unit during this period (see [10], p. 41).

B. Housing Prices and Vacancy Rates

The basic forces underlying the demand for housing accommodation are essentially the same as for other goods — population, income, prices, the cost and availability of credit and consumer preferences ([14], p. 138 and [37], p. 5) — with the demographic and income variables being most important in the long run. In the short run, population increases may be accommodated in a relatively fixed housing inventory by varying the intensity of occupancy, but in the long run, especially under conditions of rising real incomes, population growth has been the strategic factor in determining the level of residential construction (see [4], p. 56 and [20], p. 76). However, demographic influences are not confined to population or family growth. The age composition, family size and number of first and second child births also play important roles in housing demand. Unfortunately, despite numerous attempts, I was unable to introduce these variables into the model in a significant manner, and therefore demographic influences are represented solely by family and population variables.

Rising incomes exert a substantial influence on the demand for housing by increasing the quality of accommodation desired and by enabling more families to afford their own homes (see [38], pp. 149-152). Since I am only concerned in this study with the demand for housing units and not with their quality, rising incomes will stimulate demand by facilitating family 'undoubling', net family formation and the formation of non-family households (consisting primarily of single young people who move out of their parents' homes to live in separate dwellings and of middle-aged and elderly widows, widowers, bachelors, spinsters and divorcees). This occurs since higher incomes enable more population units to afford the rents or carrying costs and downpayments required to maintain separate living accommodation.

Credit variables have a strong influence on the demand for housing since for most families this demand is quite sensitive to downpayment and monthly payment requirements ([5], p. 100 and [54], p. 92); and these payments depend upon the nominal purchase price, the mortgage interest rate, the loan-to-value ratio and the amortization term of the mortgage. However, because variations in credit terms have a substantially stronger impact on the quality of housing services demanded, which is ignored in this

study, than on the number of housing units demanded,[17] much of the influence of these variations is likely to be missed in this paper.

Family demand for housing units (DH/HH) may, therefore, be thought of as a function of: permanent real family disposable income (YDP/HH), the price of housing (PH), the price of alternative goods and services (PGNE), and (to a slight extent) the cost (RM) and availability (MT) of mortgage credit. The demand for housing is expressed on a family basis because families occupy over 84 per cent of Canadian dwelling units ([10], p. 93 and [28], p. 40), and accurate data on non-family households, occupying the remaining housing units, are not available.

$$DH/HH = g\ (YDP/HH,\ PH,\ PGNE,\ RM,\ MT) \qquad (5)$$

Housing prices and vacancies can now be determined by introducing the per family stock of dwelling units (STH/HH) into the model. The stock of dwellings consists of units that are occupied (SHO) and those that are vacant (V). The stock of dwelling units existing in any period is identically equal to the stock of the previous period plus completions (C) and conversions (CON) less removals and demolitions (RD). If conversions, removals and demolitions are considered to be a function of past stock, and completions a function of lagged starts, the supply of housing units is a function of the previous stock and lagged starts, i.e.,

[17]The Consumer Survey prepared for the Royal Commission on Banking and Finance ([6], p. 100) shows that a 10 per cent increase in downpayment requirements would have caused 6 per cent of home purchasers, using mortgage credit during 1957-1962, to purchase cheaper homes; and that a 10 per cent increase in monthly payment requirements would have caused 12 per cent to 15 per cent of home purchasers to purchase cheaper homes. Moreover, these same credit variations would have caused reductions of 9 per cent, and 20 per cent to 25 per cent, respectively, in new home purchases. A significant proportion of these purchases would have occurred to upgrade accommodation, since over a third of home purchases are made by families previously occupying their own dwellings (see [10], p. 68).

$$\text{if} \quad CON = bSTH_{t-1},\ RD = b'STH_{t-1},\ \text{and } C = \sum_{i=0}^{n} C_i\ HST_{t-i},$$

$$\text{then } \Delta STH = (b - b')\ STH_{t-1} + \sum_{i=0}^{n} C_i\ HST_{t-i},$$

$$\text{and} \quad STH = (1 + b - b')\ STH_{t-1} + \sum_{i=0}^{n} C_i\ HST_{t-i}.$$

Hence,

$$(STH/HH) \equiv (SHO/HH) + (V/HH) = f[(STH/HH)_{t-1},\ \sum_{i=0}^{n} \beta_i\ (HST/HH)_{t-i}] \tag{6}$$

Housing prices and vacancies may now be determined by interacting the demand for and supply of these housing units.

$$PH = p(YDP/HH,\ PGNE,\ RM,\ MT,\ SHO/HH,\ V/HH) \tag{7}$$

$$V/HH = v(YDP/HH,\ PGNE,\ RM,\ MT,\ SHO/HH,\ PH) \tag{8}$$

Estimates of equations (6) and (7), after modifications necessitated by data limitations, are presented in equations (9), (10) and (11). I did not estimate equation (8) because reliable vacancy data were unavailable. The modifications consist of the use of total housing stock (STH) rather than separate SHO and V variables since vacancy data are lacking, and the proxy for MT is eliminated because of its insignificance. Coefficients on the lagged housing start variable in equation (9) were estimated by the Almon technique using second and third degree Almon variables[18] (see [2], and [50]).

[18]The actual estimated housing stock regression is:

$$STH = \underset{(680.78)}{.9997}\ STH_{t-1} + \underset{(4.29)}{3.70}\ Z_2 - \underset{(3.76)}{2.74}\ Z_3$$

$R^2 = .99$ $\qquad$ D/W = 2.03

where Z_2 and Z_3 are second and third degree Almon variables created on housing starts.

2Q54-4Q65

$$STH = \underset{(680.78)}{.9997}\ STH_{t-1} + \underset{(2.85)}{.224}\ HST + \underset{(5.07)}{.372}\ HST_{t-1}$$

$$+ \underset{(4.69)}{.275}\ HST_{t-2} + \underset{(4.44)}{.096}\ HST_{t-3} \qquad (9)$$

SEE = 6.62 $\qquad R^2 = .99 \qquad$ D/W = 2.03

Equation (9) indicates that the existing housing stock is determined by the past stock of houses and current housing completions, where housing completions are represented by past housing starts. The lagged housing stock coefficient of less than 1 in the housing stock regression suggests that demolitions and removals exceed conversions (i.e., that $|b'| > b$) since these variables were all assumed to be a function of the lagged stock. The coefficients on the lagged housing start variables indicate an average construction period of just over one and two-thirds quarters assuming housing starts are uniformly distributed within each quarter.[19]

1Q57-4Q65

$$PH = \underset{(.87)}{43.8} + \underset{(.83)}{.9}\ Q1 + \underset{(3.30)}{3.6}\ Q2 + \underset{(1.71)}{1.8}\ Q3 + \underset{(1.11)}{32.03}\ (YDP/HH)_{t-1}$$

$$- \underset{(1.33)}{120.96}\ (STH/HH) + \underset{(4.10)}{1.62}\ PGNE_{t-1} - \underset{(1.16)}{2.98}\ RM_{t-1} \qquad (10)$$

SEE = 2.05 $\qquad R^2 = .92 \qquad \bar{\bar{R}}^2 = .90 \qquad$ D/W = 1.06

[19]The average construction period was calculated by assuming that housing starts are uniformly distributed within each quarter. Thus there is an average one-half quarter lag for housing stock changes (which arise from completions) behind housing starts in the current quarter, an average one and one-half quarter lag for changes in stock behind starts in the previous quarter, etc.

$$PH = \underset{(.38)}{23.4} + \underset{(.91)}{.7}\ Q1 + \underset{(3.31)}{3.0}\ Q2 + \underset{(2.29)}{1.7}\ Q3 + \underset{(1.46)}{49.16}\ (YDP/HH)_{t-1}$$

$$- \underset{(.57)}{60.05}\ (STH/HH) + \underset{(1.88)}{.79}\ PGNE_{t-1} - \underset{(.24)}{.77}\ RM_{t-1} \qquad (10')$$

SEE = 1.70 $\quad\rho$ = .470 $\quad$ D/W = 1.24

1Q57-4Q65

$$PH = \underset{(1.70)}{74.1} + \underset{(1.10)}{1.1}\ Q1 + \underset{(3.44)}{3.8}\ Q2 + \underset{(2.03)}{2.0}\ Q3 + \underset{(2.95)}{57.13}\ (YDP/HH)_{t-1}$$

$$- \underset{(2.40)}{180.89}\ (STH/HH) + \underset{(3.94)}{1.44}\ PGNE_{t-1} \qquad (11)$$

SEE = 2.06 $\quad R^2$ = .92 $\quad \bar{\bar{R}}^2$ = .90 $\quad$ D/W = .97

$$PH = \underset{(.36)}{21.1} + \underset{(.98)}{.7}\ Q1 + \underset{(3.40)}{2.9}\ Q2 + \underset{(2.60)}{1.7}\ Q3 + \underset{(1.98)}{53.64}\ (YDP/HH)_{t-1}$$

$$- \underset{(.61)}{56.15}\ (STH/HH) + \underset{(1.66)}{.66}\ PGNE_{t-1} \qquad (11')$$

SEE = 1.65 $\quad\rho$ = .515 $\quad$ D/W = 1.25

The housing price regressions indicate that housing prices vary directly with permanent real disposable income per family and the price of alternative goods and services, and inversely with the per family size of the existing housing stock. Unfortunately our cost-of-credit and credit-rationing variables failed to perform as anticipated, since the credit-rationing variable had the wrong sign and the cost-of-credit variable was insignificant. One explanation for these failures is the fact that credit variables have a stronger influence on the quality of housing demanded than on the unit or stock demand; and that those stock-demand influences that exist fall primarily on the allocation of housing demand between owner and rental units rather than on the total

demand for housing.[20] A further explanation is to be found in the degree of aggregation in, and nature of, the price and interest-cost variables used in this study.

First, the housing-price variable is an average of an index of housing prices compiled by Multiple Listing Service sales (co-operative sales by members of Canadian real estate boards), roughly representing an index of prices of existing houses, and an index of prices of new NHA houses based upon the cost of new NHA houses.[21] Varying interest costs may affect the prices of existing and new houses in opposite ways. Traditionally, rising borrowing costs are expected to reduce housing demand and hence housing prices by increasing monthly carrying costs and leading to more stringent non-price borrowing terms. However, in the case of new houses a different mechanism may be operating, since purchasers of new houses usually assume the mortgage arranged by the builder prior to the commencement of construction. Thus an increase in current mortgage rates would be expected to exert upward pressure on prices since new houses currently for sale are available with financing at the old 'bargain' rate and housing prices, in a sense, become the rationing mechanism for scarce mortgage credit.

Second, the mortgage rate variable is an average of the prime conventional mortgage rate of six life insurance companies and the actual NHA mortgage rate. Since vendors very often 'take back' substantial mortgages on the sale of their houses ([37], pp. 34-36), it is unlikely that my mortgage rate is representative of the rate charged on a large portion of the mortgage financing used in the purchase of existing houses. Similarly, although the RM - RB variable is a satisfactory proxy for the availability of new mortgage credit from financial institutions, RM - RB may be quite an inadequate representation of the tightness in the secondary and vendor mortgage markets.

Since the price and mortgage rate variables used in this study embody these conflicting forces, it is not surprising that the mortgage rate and credit-rationing variables are not signifi-

[20]The factors affecting the allocation of housing demand are discussed more thoroughly in section 4.

[21]See footnote 15.

cant in the housing-price regressions. Consequently, my results should not be interpreted as an indication that no significant relationship exists between housing prices and financial market conditions, but only that my highly aggregative data did not detect any significant relationship.

Finally, in interpreting these results extreme caution must be exercised as a consequence of the presence of serially correlated residuals in the price regressions, indicated by the low Durbin/Watson statistics [16], and the inclusion of a lagged dependent variable in the housing-stock equation. This variable biases the Durbin/Watson statistic toward 2.0 and inhibits the detection of serial correlation [34].

In an effort to eliminate these problems I attempted autoregressive transformations using the procedure suggested by Hildreth and Lu [26]. The results indicate that serial correlation is not a problem in the housing stock regression since the autoregressive parameter, ρ, which minimizes the residual variance of equation (5), is -.032. However, in the price regressions I ran into a further problem because the search procedure indicates that a ρ greater than 1 minimizes the residual variance of equations (10) and (11). This is unsatisfactory because it implies an explosive process and suggests that a first-order autoregressive transformation may not be appropriate. Nevertheless, since the price equations have no lagged dependent variables, I persisted with a Theil/Nagar transformation [52]. The results of these transformations, presented in equation (10') and (11'), indicate some substantial coefficient changes on the (STH/HH), $PGNE_{t-1}$ and RM_{t-1} variables. The low Durbin/Watson statistic indicates that, as expected, the transformations have not eliminated the serial correlation in the residuals.

C. Construction and Land Costs

To complete the housing sector, consideration must be given to the factors affecting construction costs and land costs. The measure of construction costs in this section is an index of the average cost of construction (including land costs) per square foot on new government-insured single detached dwellings. Variations in this index were assumed to be influenced by changes in

average hourly earnings in construction (WC), changes in temporary or bridge financing costs (R03),[22] changes in land costs (L), changes in the cost of building materials, and the delays and bottlenecks that arise as current residential construction (IRC) and non-residential construction (INRC) press against their respective industrial capacities. Since changes in the cost of building materials are highly correlated with changes between residential and non-residential construction and their respective industrial capacities, the building material variable was deleted from the model and its impact was assumed to be reflected in the coefficients on the capacity variables and a sales tax dummy variable (DVST). DVST, which has the value 1 from 3Q63 to 4Q65 and zero elsewhere, was included to reflect the influence of the imposition in stages of a sales tax on building materials between June 1963 and December 1965.[23] The degree of capacity utilization in residential and non-residential construction was assumed to be represented by the deviations of residential and non-residential construction expenditure from their seasonally adjusted logarithmic trends.

The estimated regressions in logarithmic form, presented in equations (12) to (14), indicate that all the included variables significantly influence construction costs. The construction cost equation is estimated in terms of annual changes in quarterly form owing to the inclusion of the wage variable and the amount of random noise inherent in the measure of construction costs. Although this procedure does not introduce bias into the estimates it does impair the efficiency of the least squares estimates by building serial correlation into the model and reducing the number of truly independent observations (see [36], pp. 30-31, and [41], pp. 326-327).

[22]The short-term government bond rate (R03) was used as a proxy for the cost of bridge financing or temporary financing because a direct measure of this variable does not exist in Canada.

[23]An 11 per cent federal sales tax was imposed on building materials in 1963, taking effect as follows: 4 per cent after June 1963, 8 per cent after April 1964, and 11 per cent after January 1965.

1Q53-4Q67

$$\ln \widehat{IRC}^{24} = \underset{(141.89)}{5.93} - \underset{(8.51)}{.349}\ Q1 - \underset{(2.24)}{.092}\ Q2 - \underset{(.20)}{.008}\ Q3 + \underset{(3.19)}{.0027}\ T \tag{12}$$

SEE = .11 $\qquad R^2 = .66 \qquad$ D/W = .70

1Q53-4Q67

$$\ln \widehat{INRC}^{24} = \underset{(118.65)}{6.25} - \underset{(7.16)}{.370}\ Q1 - \underset{(1.67)}{.086}\ Q2 - \underset{(2.03)}{.105}\ Q3 + \underset{(8.09)}{.0085}\ T \tag{13}$$

SEE = .14 $\qquad R^2 = .75 \qquad$ D/W = .33

3Q55-4Q65

$$\begin{aligned} \ln CLC - \ln CLC_{t-4} &= \underset{(.51)}{-.0031} + \underset{(1.92)}{.039}\ (\ln INRC - \ln \widehat{INRC})_{t-1} \\ &+ \underset{(3.81)}{.090}\ (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.13)}{.13}\ (\ln WC - \ln WC_{t-4}) \\ &+ \underset{(2.58)}{.11}\ (\ln L - \ln L_{t-4}) + \underset{(3.30)}{.030}\ (\ln R03 - \ln R03_{t-4}) \\ &+ \underset{(5.11)}{.029}\ DVST \end{aligned} \tag{14}$$

SEE = .014 $\qquad R^2 = .78 \qquad$ D/W = 1.56

[24] $\ln \widehat{INRC}$ and $\ln \widehat{IRC}$ appear in RDX1 as LINE (11449) and LIRE (11450), respectively. Their corresponding equations were estimated over the sample period, 1953-1965.

$$\ln CLC - \ln CLC_{t-4} = \underset{(.55)}{-.0038} + \underset{(1.70)}{.039} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.05)}{.076} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.08)}{.14} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.43)}{.12} (\ln L - \ln L_{t-4}) + \underset{(3.07)}{.030} (\ln R03 - \ln R03_{t-4})$$

$$+ \underset{(4.23)}{.029} DVST \qquad (14')$$

SEE = .013 $\qquad \rho = .267 \qquad$ D/W = 1.82

Unfortunately, the CLC equation has a fair amount of multicollinearity so that one cannot place too much reliability on the coefficients of all the variables even though there is a great deal of stability between the transformed and untransformed coefficients. This is particularly true for the average hourly earnings in construction variable (WC). It appears to have a much greater impact on construction costs when the chartered bank day loan rate (RDL) is used, for example, instead of the short-term government bond rate (R03) as a proxy for the cost of temporary construction loans (see equation (15)).

3Q55-4Q65

$$\ln CLC - \ln CLC_{t-4} = \underset{(1.14)}{-.007} + \underset{(1.26)}{.030} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(4.83)}{.11} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.74)}{.21} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(3.04)}{.14} (\ln L - \ln L_{t-4}) + \underset{(1.99)}{.010} (\ln RDL - \ln RDL_{t-4})$$

$$+ \underset{(4.30)}{.026} DVST \qquad (15)$$

SEE = .015 $\qquad R^2 = .74 \qquad$ D/W = 1.48

$$\ln CLC - \ln CLC_{t-4} = \underset{(.80)}{-.006} + \underset{(1.17)}{.030} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.25)}{.085} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.47)}{.21} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.62)}{.14} (\ln L - \ln L_{t-4}) + \underset{(1.83)}{.010} (\ln RDL - \ln RDL_{t-4})$$

$$+ \underset{(3.38)}{.026} DVST \qquad (15')$$

$SEE = .014$ $\qquad \rho = .354$ $\qquad D/W = 1.79$

Similarly, if construction costs are defined as the average cost of construction per square foot on new government-insured single detached dwellings, excluding land costs, and land costs are deleted as an explanatory variable (see equation (49) in section 4), regardless of what interest rates are used as a proxy for the cost of temporary financing, average hourly earnings exert a much greater influence on construction costs than when construction costs are defined to include land costs (as in equation (14)). However, the coefficients on all the other variables are remarkably similar.

Land costs, measured as an index of the cost of land used in the construction of new NHA single detached dwellings, are assumed to be determined by the demand for residential land.[25] The cost of land, therefore, is thought to vary directly with population (POPT), permanent real disposable income, and expectations as to future land prices (where expectations are extrapolative and represented by past changes in land prices), and inversely with the size of the existing housing stock.

[25]The specification of equation (16) has been greatly simplified by assuming that the supply of residential land is a constant. In fact the supply of usable residential land increases with the availability of transportation, water, electricity and other services and the proclamation of zoning regulations, so that most of these increases in the supply of usable land have been anticipated by developers and speculators and therefore are not increases in the usual sense.

2Q54-4Q65

$$L = -141.5 + \underset{(5.81)}{} \; .042\ POPT \underset{(6.55)}{} + .030\ YDP \underset{(4.38)}{} - .15\ STH \underset{(5.09)}{} + .59\ \Delta L \underset{(5.08)}{} \quad (16)$$

SEE = 4.11 $\qquad R^2 = .96 \qquad$ D/W = .77

$$L = -123.2 + \underset{(4.05)}{} \; .036\ POPT \underset{(4.85)}{} + .027\ YDP \underset{(3.38)}{} - .13\ STH \underset{(3.79)}{} + .50\ \Delta L \underset{(6.39)}{} \quad (16')$$

SEE = 3.47 $\qquad \rho = .324 \qquad$ D/W = 1.34

D. The Mortgage Market

The importance of the mortgage market to the housing sector is apparent from the above discussion, since the terms and availability of mortgage credit were shown to have a direct bearing both on user demand for housing and on the willingness and ability of builders and developers to undertake new construction.[26] Because of the multiplicity of sectors in RDX1, the RDX1 mortgage sector has been confined to a single mortgage rate determination equation, which provides the linkage between the real and financial components of the housing market. However, although a complete mortgage sector is not included in RDX1, there is an elaborate mortgage market specification underlying and consistent with the mortgage rate determination equation. This specification, which is partially developed here, will be completed and estimated in section 3.

The demand for mortgage credit for residential construction is directly related to the demand for this construction, and is primarily influenced by the same variables as is the demand for housing (see [25], p. 59 and [27], p. 476). In addition, the demand for mortgage credit depends upon the cost of this credit relative to the cost of alternative sources of funds, including the opportunity cost of equity financing. For estimation purposes

[26]For a further development of these relationships see [29] and [37].

the demand for private mortgage credit (DM)[27] may be summarized as: a function of permanent real family disposable income (YDP/HH), the per family stock of dwelling units (STH/HH), the cost (RM) and non-price borrowing terms (MT) of this credit, and the cost of alternative sources of funds. This last variable is represented by a weighted average of the yields on long-term federal, provincial, municipal, corporate and public utility bonds (RB).[28]

$$DM = d\ (YDP/HH,\ STH/HH,\ RM,\ RB,\ MT) \qquad (17)$$

The supply of mortgage credit for new residential construction in Canada comes from both private financial institutions and Central Mortgage and Housing Corporation (CMHC), a government corporation. Government lending is quite distinct from private lending since the former occurs 'as a last resort' when sufficient private financing is not available. Government lending is considered to be a policy variable in this paper.[29] On the other hand private lending; which originates primarily from life insurance companies, chartered banks, trust companies and mortgage loan companies; responds to market forces and essentially depends upon the desirability of mortgage investments relative to alternative investment opportunities. This desirability, and hence the extent to which institutional flows will be directed toward mortgage investment, depends upon the discrepancy between an institution's actual (M^i) and desired (M^{i*}) stock of mortgage investments; where an institution's desired stock is based upon a comparison of present and expected mortgage yields (RM) and non-price terms (MT) with the present and expected yields (RB) and other terms (BT) of alternative security investments, and upon the size of the institutions investment portfolio (A^i).[30] Since most institutional

[27]Since government lending performs a residual function ([12], p. iv, and [37], p. 100), all demand for mortgage credit is considered initially to be a demand for private mortgage credit.

[28]Weights are in proportion to bonds outstanding, i.e. — .5, .2, .1, .1 and .1, respectively.

[29]For a discussion of the role of Central Mortgage and Housing Corporation see [12], pp. 18-20, [37], pp. 98-103, and [5], pp. 269-284.

[30]For some general examples of financial stock adjustment models see [13] and [19], and for some applications of this approach for the mortgage market see [43], [48] and [51].

mortgages are amortized, a significant proportion (θ) of an institution's mortgage portfolio is returned during each period in the form of principal repayments, and the expected size of these repayments (RE) should be taken into consideration when institutions make their investment decisions.

Hence, factors affecting the volume of mortgage approvals made by the i^{th} institution may be summarized by the following equations:

$$MA^i = \gamma \ (M^{i*} - M^i_{t-1}) + \delta \ RE^i,$$

$$M^{i*} = m \ (RM, RB, A^i, MT, BT),$$

and

$$RE^i = \theta \ (M^i_{t-1}).$$

These equations reduce to

$$MA^i = \gamma \ m \ (RM, RB, A^i, MT, BT) - (\gamma - \theta\delta) \ M^i_{t-1}. \qquad (18)$$

The total supply of private mortgage credit (SM) is then considered to be the sum of the mortgage approvals made by life insurance companies, chartered banks, trust companies and mortgage loan companies.

$$SM \equiv \sum_{i=1}^{4} MA^i, \qquad (19)$$

where i refers to the main institutions engaged in mortgage lending.

Although the interaction of basic demand and supply functions is sufficient to determine security yields and other lending terms in most security markets, the existence of separate government-insured (NHA) and conventional mortgage debt instruments complicates this procedure in the mortgage market. NHA mortgages are government-insured mortgages with lending terms and yields under government supervision, while conventional mortgages are uninsured

and essentially free of government controls. Since conventional mortgages have no special features to mitigate their inherent risk they typically carry higher yields and more stringent borrowing terms than NHA mortgages.[31] Up to this point I have largely ignored the distinction between these forms of mortgages, and I have used a mortgage rate (RM) that is the average of the conventional mortgage rate (RC) and the government-insured mortgage rate (RNHA),[32] where (RNHA) is considered to be an exogenous policy variable.[33]

$$RM \equiv (RC + RNHA)/2 \qquad (20)$$

The NHA rate should now be introduced explicitly into the demand and supply functions in order to determine the conventional rate, since NHA mortgages are an important alternative source of funds to conventional mortgages for borrowers and an important alternative form of investment to conventional mortgages open to financial institutions (see [45], pp. 420-427). Thus, the demand for (DCM) and supply of (SCM) conventional mortgage credit becomes

$$DCM = d' \; (YDP/HH, STH/HH, RC, RNHA, RB, MT) \qquad (21)$$

and

$$SCM \equiv \sum_{i=1}^{4} C\,MA^{i} = s\,(RC, RNHA, RB, MT, BT, \sum_{i=1}^{4} \beta_i A^{i}, \sum_{i=1}^{4} \gamma_i M^{i}). \qquad (22)$$

[31]For a more detailed discussion of the difference between NHA and conventional mortgages and government housing legislation see [12], pp. 60-64, [37], pp. 25-32, [5], pp. 269-273, and [55], pp. 10-30.

[32]Since the size of conventional and NHA mortgage flows for new residential construction was approximately equal over the estimation period, an unweighted average was used.

[33]During the period of this study the government set an interest yield ceiling rather than the actual interest yield on NHA mortgages. However, with the exception of a few months in 1955, the actual lending rate was the ceiling rate and, hence, the government may be considered to have set the lending rate.

Hence,

$$RC = r\ (RB,\ RNHA,\ MT,\ BT,\ YDP/HH,\ STH/HH,$$

$$\sum_{i=1}^{4} \beta_i A^i,\ \sum_{i=1}^{4} \gamma_i M^i). \qquad (23)$$

The estimated untransformed and transformed mortgage rate determination regressions are presented in equations (24) and (24'), with MT and BT assumed to be impounded in the disturbance term and with institutional investment portfolios approximated by the total asset holdings of each institution. Because institutions wish to invest different proportions of their investment portfolios in mortgages (see the discussion in section 3), a total institutional investment portfolio variable (ALTM) was created such that each institution's asset holdings are weighted by the coefficient on the institution's portfolio variable in the regressions presented in Table 1 (see pp. 32-33). For consistency, these weights were also applied to the mortgage holdings of each institution to create the institutional mortgage stock variable (MLTM). Since the chartered banks were legally prohibited from participating in the conventional mortgage market prior to 1967, the total institution investment portfolio and mortgage stock variables are the weighted sums of life insurance company (L), trust company ((T) or (T')), and mortgage loan company (M) asset and mortgage holdings only, i.e.,

$$ALTM = .21\ (AL - PL) + .13\ AT + .31\ AM$$

and

$$MLTM = .21\ ML + .13\ MT' + .31\ MM.$$

2Q54-4Q65

$$\underset{(3.20)}{RC = 9.7} - \underset{(2.95)}{8.85}\ (STH/HH)_{t-1} + \underset{(3.16)}{3.17}\ (YDP/HH) - \underset{(6.02)}{.0031}\ ALTM$$

$$+ .0045\ MLTM_{t-1} + .38\ RNHA + .32\ RB_{t-1} \qquad (24)$$
$$\quad (5.76) \qquad\qquad (4.49) \qquad (4.49)$$

SEE = .092 $\qquad R^2 = .96 \qquad$ D/W = 1.14

$$RC = 11.5 - 11.21\ (STH/HH)_{t-1} + 3.72\ (YDP/HH) - .0020\ ALTM$$
$$\quad (2.82)\ (2.69) \qquad\qquad (3.32) \qquad\qquad (3.18)$$

$$+ .0029\ MLTM_{t-1} + .32\ RNHA + .32\ RB_{t-1} \qquad (24')$$
$$\quad (3.21) \qquad\qquad (3.42) \qquad (4.33)$$

SEE = .078 $\qquad \rho = .564 \qquad$ D/W = 2.00

In addition to depending upon the size of institutional total asset and mortgage holdings, the conventional mortgage rate is strongly influenced by the lagged bond rate, the NHA mortgage rate, permanent real family disposable income and the per family housing stock. Although this specification has a rather nice structural rationale and interpretation, for predictive purposes two highly simplified formulations perform almost as well. In these formulations the conventional mortgage rate is solely a function of the lagged bond rate and the change in the bond rate (equation 25), or a function of the lagged bond rate, the change in the bond rate and the current NHA mortgage rate (equation 26).

2Q54-4Q65

$$RC = 4.13 + .54\ RB_{t-1} + .24\ \Delta\ RB \qquad (25)$$
$$\quad (27.88)\ (17.86) \qquad (1.99)$$

SEE = .153 $\qquad R^2 = .88 \qquad$ D/W = .38

$$RC = 4.22 + .53\ RB_{t-1} + .21\ \Delta\ RB \qquad (25')$$
$$\quad (12.61)\ (8.02) \qquad (2.85)$$

SEE = .089 $\qquad \rho = .804 \qquad$ D/W = 1.43

2Q54-4Q65

$$RC = \underset{(8.61)}{3.50} + \underset{(1.63)}{.19}\ RNHA + \underset{(5.76)}{.43}\ RB_{t-1} + \underset{(2.31)}{.28}\ \Delta\ RB \qquad (26)$$

SEE = .150 $\qquad R^2 = .89 \qquad$ D/W = .44

$$RC = \underset{(7.74)}{4.15} + \underset{(.17)}{.02}\ RNHA + \underset{(6.34)}{.52}\ RB_{t-1} + \underset{(2.74)}{.21}\ \Delta\ RB \qquad (26')$$

SEE = .090 $\qquad \rho = .802 \qquad$ D/W = 1.44

3. THE MORTGAGE SECTOR OF RDX1 EXTENDED

Underlying and consistent with the mortgage rate determination equation in the preceding section is a specification of the mortgage lending behaviour of financial institutions. In this specification the volume of an institution's mortgage lending activity depends upon the relative yields available on mortgages and alternative investments, the size of an institution's investment portfolio (represented by the institution's total asset holdings or deposit liabilities), and the size of an institution's existing mortgage holdings (equation (18)). In this section the above relationship is examined for each of the major financial institutions in the mortgage market. In addition, because the size of the investment portfolios or deposit liabilities of these institutions exerts a significant influence on their mortgage investment behaviour, the factors affecting the size of these investment portfolios or deposit liabilities are briefly examined.[34]

[34]For a more elaborate specification and an integration of financial institution inflows of funds and mortgage lending activity see [46].

A. Financial Institutions — Mortgage Lending Behaviour

Because mortgage approvals, rather than mortgage disbursements or net investments that arise out of mortgage approvals, respond to current economic conditions and represent the actual mortgage investment decisions of financial institutions, mortgage approvals are used in this study to represent the mortgage lending behaviour of these institutions. This behaviour is set out in equation (27), which was developed in the previous section. The equation is estimated for the chartered banks, life insurance companies, trust companies and mortgage loan companies. These regression results in untransformed and transformed form are presented in Table 1.

$$MA^i = \gamma m\ (RM, RB, A^i, MT, BT) - (\gamma - \theta\delta)\ M^i_{t-1} \qquad (27)$$

where: γ is the stock-adjustment coefficient,

δ is the proportion of the instution's expected mortgage repayments reinvested (in the approval sense) in mortgages during the current period, and

θ is the proportion of an institution's mortgage portfolio expected to be repaid during the current period.

In order to integrate the mortgage section into the basic RDX1 model and to close the model further by determining the total mortgage stock variable (MLTM), which appears in the conventional mortgage rate determination equation (23), the mortgage approval equation (27) can be transformed into a net mortgage investment equation, equation (28). This can be done by deleting repayments (since the dependent variable is now expressed in net terms) and building a lag structure into the model to reflect the time lag between the commitment and disbursement of funds (see [29], pp. 143-146). Net mortgage investment equations (ΔM) for each finantial institution are presented in Table 2. However, no special discussion of these regressions is conducted because of the similarity between them and the regressions for mortgage approvals presented in Table 1.

$$\Delta M^i = \gamma' m'\ (RM, RB, A^i, MT, BT) - \gamma' M^i_{t-1} \qquad (28)$$

Because bonds are the major alternative to mortgage investments for the majority of financial institutions included in this study,[35] a weighted average of the yields on long-term federal, provincial, municipal, corporation and public utility bonds (RB) was used to represent alternative security yields. This rate was combined, in differential form to relieve multicollinearity, with the mortgage rate (RM), an average of the National Housing Act (NHA) rate and the conventional mortgage rate, to represent the relative yield desirability of mortgage investments. In the case of the chartered banks, authorized to initiate only NHA mortgages as opposed to conventional mortgages prior to 1967, the yield differential between NHA mortgages and long-term Government of Canada bonds (RNHA - RLC) rather than the yield differential between all mortgages and bonds (RM - RB) was used to represent relative yield considerations. In order to allow for lagged responses my interest yield variables were introduced currently and in distributed lag form using Almon variables [2].

The chartered bank mortgage regression was estimated from mid-1954 to the end of 1959 because this was the only period prior to 1967 during which banks actively participated in mortgage lending. Since life insurance company policy loans (PL) vary in response to the demands of borrowers rather than the preferences of investors ([7], p. 62), funds invested in policy loans were not considered to form part of life insurance company investment portfolios in the usual sense and were netted out of the life company investment portfolio variable (AL - PL). In order to examine the influence of policy loans on investment decisions of life companies in more detail, a second specification of the model was attempted with life insurance company total assets (AL) and policy loans included separately.

The mortgage lending regressions in Tables 1 and 2 indicate that mortgage lending by financial institutions is significantly influenced by relative interest yields, the size of existing investment portfolios and the size of existing mortgage holdings; and that the strength of these variables varies between institu-

[35]Although loans rather than bonds provide the main investment alternatives to mortgages for the chartered banks, the mortgage yield to bond yield differential probably provides a better indication of the relative desirability of mortgage investments than the mortgage yield to loan yield differential because of the ceiling imposed on bank lending rates during the estimation period.

Table 1

MORTGAGE APPROVAL REGRESSIONS FOR CANADIAN FINANCIAL INSTITUTIONS

	Constant	Q1	Q2	Q3	AL - PL	AL	TBA	AT	AM	PL
Chartered	-517.6	-17.0	40.0	33.1			.054			
Banks ≠	(4.54)	(1.52)	(3.73)	(3.18)			(4.84)			
	-508.1	-16.9	40.0	33.1			.053			
	(4.20)	(1.56)	(3.74)	(3.31)			(4.48)			
Life	-503.4	-13.4	51.3	16.4	.212					
Insurance	(7.38)	(1.49)	(5.67)	(1.82)	(6.00)					
Companies										
	-543.3	-13.4	50.0	15.3	.248					
	(5.17)	(2.04)	(6.53)	(2.25)	(4.28)					
	-235.2	-13.7	54.1	19.6		.216				-1.61
	(2.99)	(1.89)	(7.37)	(2.68)		(7.57)				(5.47)
	-238.3	-13.8	54.0	19.5		.217				-1.61
	(2.92)	(1.94)	(7.36)	(2.72)		(7.30)				(5.24)
Trust	-93.3	-12.1	23.3	14.7				.132		
Companies	(3.17)	(1.32)	(2.57)	(1.68)				(4.69)		
	-93.4	-9.8	24.2	15.5				.124		
	(3.73)	(.99)	(2.76)	(1.61)				(5.02)		
Mortgage	28.0	1.7	23.3	-1.3					.330	
Loan	(1.00)	(.22)	(2.99)	(.17)					(3.55)	
Companies										
	18.3	2.3	24.6	.2					.241	
	(.50)	(.36)	(3.41)	(.03)					(2.54)	
	5.8	1.7	23.3	-1.1					.313	
	(.62)	(.23)	(3.01)	(.14)					(3.46)	
	6.6	2.3	24.6	.3					.228	
	(.59)	(.36)	(3.49)	(.05)					(2.46)	
	-29.4	6.5	28.4	6.0						
	(1.37)	(1.06)	(4.61)	(.98)						
	-29.4	6.5	28.3	6.0						
	(1.31)	(1.08)	(4.61)	(1.00)						

≠ The interest variable used in equation (1) is (RNHA - RLC).

* This variable has the wrong sign and is insignificant.

DEP	M_{t-1}	$(RM - RB)_{t-i}$				R^2	$\bar{\bar{R}}^2$	SEE	D/W	ρ	Estimation Period
		i = 0	i = 1	i = 2	i = 3						
	-.154	30.54				.80	.60	18.00	1.78		2Q54-4Q59
	(3.77)	(1.94)									
	-.153	29.35						17.95	1.89	.080	
	(3.51)	(1.76)									
	-.252	23.33	17.50	11.66	5.83	.90	.87	21.94	1.15		1Q54-4Q65
	(4.49)	(3.21)	(3.21)	(3.21)	(3.21)						
	-.311	19.91	14.93	9.95	4.98			19.86	2.11	.449	
	(3.38)	(1.92)	(1.92)	(1.92)	(1.92)						
	-.178	15.04	11.28	7.52	3.76	.93	.91	17.72	1.83		
	(3.73)	(2.45)	(2.45)	(2.45)	(2.45)						
	-.181	14.96	11.22	7.48	3.74			17.71	1.90	.042	
	(3.63)	(2.35)	(2.35)	(2.35)	(2.35)						
	-.106	7.11	5.33	3.56	1.78	.92	.91	20.03	1.82		1Q55-4Q65
	(2.01)	(1.29)	(1.29)	(1.29)	(1.29)						
	-.088	7.39	5.54	3.70	1.85			19.86	1.76	-.190	
	(1.90)	(1.60)	(1.60)	(1.60)	(1.60)						
	-.394	-4.20*	-3.15*	-2.10*	-1.05*	.81	.80	17.56	1.44		1Q55-4Q65
	(2.93)	(.84)	(.84)	(.84)	(.84)						
	-.269	-2.34*	-1.75*	-1.17*	-.58*			17.04	1.99	.327	
	(1.98)	(.34)	(.34)	(.34)	(.34)						
	-.363					.81	.80	17.49	1.38		
	(2.82)										
	-.249							16.84	2.00	.354	
	(1.89)										
.350	-.274	4.05	3.03	2.02	1.01	.87	.86	14.37	1.78		
(6.09)	(4.64)	(1.00)	(1.00)	(1.00)	(1.00)						
.350	-.274	4.11	3.08	2.05	1.03			14.37	1.85	.051	
(5.88)	(4.50)	(.97)	(.97)	(.97)	(.97)						

Table 2

NET MORTGAGE INVESTMENT (ΔM) REGRESSIONS FOR CANADIAN FINANCIAL INSTITUTIONS

	Constant	Q1	Q2	Q3	$(AL - PL)_{t-1}$	AL_{t-1}	TBA_{t-1}	AT_{t-1}	AM_{t-1}
Chartered	-566.8	-30.9	-19.0	2.4			.059		
Banks ≠	(4.35)	(3.15)	(2.06)	(.31)			(5.10)		
	-553.7	-30.4	-20.0	2.3			.058		
	(3.29)	(4.37)	(2.73)	(.37)			(3.87)		
Life	-159.2	-42.0	-17.2	-.9	.091				
Insurance	(3.72)	(7.53)	(3.08)	(.15)	(4.44)				
Companies									
	-151.3	-41.3	-17.0	-.8	.091				
	(2.62)	(9.17)	(3.38)	(.18)	(3.19)				
	-63.7	-41.5	-18.1	-1.2		.094			
	(1.21)	(8.10)	(3.53)	(.23)		(4.97)			
	-55.7	-41.2	-18.1	-1.2		.095			
	(.86)	(9.25)	(3.71)	(.27)		(3.97)			
Trust	-80.7	9.1	7.9	12.6				.073	
Companies	(4.81)	(1.86)	(1.60)	(2.57)				(3.94)	
	-82.1	10.3	7.7	12.9				.070	
	(6.75)	(1.72)	(1.79)	(2.17)				(5.07)	
Mortgage	-30.7	.04	6.5	9.7					.067
Loan	(1.28)	(.01)	(1.07)	(1.59)					(.76)
Companies*									
	-19.3	-2.7	5.6	9.4					.054
	(.62)	(.53)	(.98)	(1.85)					(.60)
	-22.8	.2	6.6	9.8					.080
	(3.04)	(.03)	(1.10)	(1.62)					(.99)
	-18.8	-2.7	5.6	9.4					.054
	(2.00)	(.54)	(1.00)	(1.88)					(.64)
	-40.3	-4.9	4.6	7.5					
	(2.60)	(1.09)	(1.02)	(1.68)					
	-40.4	-4.9	4.6	7.5					
	(2.61)	(1.08)	(1.03)	(1.68)					

≠ The interest yield variable used in equation (1) is (RNHA - RLC).

* A second degree Almon variable is used in the first two of these regressions.

2	DEP_{t-1}	M_{t-2}	$(RM - RB)_{t-i}$ i = 1	i = 2	i = 3	i = 4	R^2	$\bar{\bar{R}}^2$	SEE	D/W	ρ	Estimation Period
		-.145	29.70				.75	.69	15.47	1.01		2Q54-4Q59
		(4.16)	(1.85)									
		-.145	29.09						13.22	1.58	.502	
		(3.17)	(1.32)									
		-.121	7.41	5.56	3.71	1.85	.78	.57	13.58	1.32		1Q54-4Q65
		(3.77)	(1.71)	(1.71)	(1.71)	(1.71)						
		-.124	6.04	4.53	3.02	1.51			12.75	2.33	.332	
		(2.74)	(1.06)	(1.06)	(1.06)	(1.06)						
0		-.088	6.24	4.68	3.12	1.56	.82	.65	12.48	1.54		
1)		(2.75)	(1.56)	(1.56)	(1.56)	(1.56)						
3		-.089	5.42	4.06	2.71	1.35			12.08	2.26	.237	
9)		(2.21)	(1.11)	(1.11)	(1.11)	(1.11)						
		-.046	7.88	5.91	3.94	1.97	.92	.91	11.34	2.45		1Q55-4Q65
		(1.27)	(2.65)	(2.65)	(2.65)	(2.65)						
		-.039	8.22	6.16	4.11	2.05			10.71	1.96	-.367	
		(1.43)	(3.95)	(3.95)	(3.95)	(3.95)						
		-.024	1.90	1.07	.47	.12	.78	.78	14.30	1.26		1Q55-4Q65
		(.18)	(.35)	(.35)	(.35)	(.35)						
		-.012	.11	.06	.03	.01			14.02	1.52	.353	
		(.09)	(.02)	(.02)	(.02)	(.02)						
		-.044					.78	.78	14.13	1.27		
		(.38)										
		-.013							13.84	1.52	.354	
		(.11)										
	.28	-.22	4.16	3.12	2.08	1.04	.89	.88	10.41	1.72		
	(5.82)	(4.32)	(1.48)	(1.48)	(1.48)	(1.48)						
	.28	-.22	4.17	3.13	2.08	1.04			10.41	1.72	-.004	
	(5.83)	(4.32)	(1.49)	(1.49)	(1.49)	(1.49)						

tions. For example, relative interest rates exert quite a significant influence on the mortgage approvals and net mortgage investments of life insurance companies, trust companies, and chartered banks,[36] but with different lag patterns. On the other hand, relative interest rates fail to exert any influence on mortgage loan company lending when portfolio targets are expressed in terms of total assets,[37] although interest rates do have some influence when mortgage targets are expressed in terms of total deposit and debenture liabilities (DEP).[38] These findings are not really surprising since they are consistent with the legal, liquidity and traditional constraints governing the investments of all these institutions. Life insurance companies, which are virtually free of all legal and liquidity constraints and traditionally large mortgage and bond purchasers, are likely to be the group most responsive to varying yields; while mortgage loan companies, holding almost 80 per cent of their total investment portfolios in mortgages and virtually confined to this single form of investment, are not likely to be strongly influenced by varying yields. Banks and trust companies, which have considerable investment freedom but which are also subject to considerable liquidity constraint, fall somewhere in between the other two groups. The proportion of an institution's net inflow of funds or net increase in assets that generates mortgage approvals (the marginal propensity to approve mortgages with respect to net asset growth) also varies as expected between institutions; being highest for mortgage loan companies at 31 per cent and lowest for banks at 5 per cent, with life insurance companies at 21 per cent and trust companies at 13 per

[36]With two exceptions, the interest rate variable is significant in these regressions at the 5 per cent confidence level using a one-tailed test. In the trust company mortgage approval regression, the variable is significant at the 10 per cent level, and in the second life company net investment regression the variable is significant at the 7 per cent level.

[37]The interest rate variable is insignificant in the net investment regression and insignificant with the wrong sign in the mortgage approval regression, when mortgage loan company investment targets are specified in terms of total assets (see Tables 1 and 2, equation (31)).

[38]Since mortgage loan companies have quite substantial and volatile short-term borrowings from other financial institutions, and since these borrowings are reflected in the asset positions of the companies but not in their deposit liabilities, it might be more reasonable to express their portfolio targets in terms of deposit and debenture liabilities rather than in terms of total assets.

cent falling in the middle. Consequently, because of the different interest sensitivities and different proportions of investment flows devoted to mortgages, the allocation of funds between institutions will also have a significant influence on total mortgage lending.

If some assumptions are made concerning the proportion of expected repayments that institutions plan to reinvest in mortgages (δ), and the proportion of an institution's mortgage portfolio expected to be repaid in the current period (θ), the stock adjustment coefficients in the mortgage approval regressions can be calculated. If one assumes that institutions plan to reinvest all their mortgage repayments in mortgages (i.e., $\delta = 1$), and that chartered banks receive mortgage repayments each quarter equivalent to 2.2 per cent, life insurance companies receive repayments equivalent to 2.3 per cent, trust companies receive repayments equivalent to 6.4 per cent and mortgage loan companies receive repayments equivalent to 4.4 per cent of their total mortgage portfolios (i.e., that θ = .022, .023, .064 and .044 respectively),[39] then chartered banks have a stock adjustment coefficient (γ) of .176, life insurance companies of .275, trust companies of .170 and mortgage loan companies of .407 using the untransformed coefficients.[40] These figures imply that the chartered banks will require approximately four quarters, life insurance companies approximately two quarters, trust companies approximately four quarters and mortgage loan companies approximately one and one-half quarters to remove half the discrepancy between their desired and actual mortgage holdings. These figures also imply an equilibrium desired proportion of mortgages to total assets of 31 per

[39]Mortgage repayment proportions are the average of each institution's gross annual decrease in mortgages outstanding ([11], Table 9) divided by the average of its initial and year-end mortgage holdings ([11], Table 3) calculated over the estimation period for each institution, and then divided by 4 to arrive at a quarterly basis. The θ's compare with the estimate of the Canadian Life Insurance Officers' Association ([5], p. 44) of 11 per cent annual repayments for life insurance companies (θ = .027) and the estimate of the University of Western Ontario ([53], p. 125) of 36 per cent annual repayments for trust companies (θ = .090). These two estimates imply stock adjustment coefficients of .280 and .196 for life and trust companies, respectively.

[40]If the coefficients from the transformed regressions are used for these calculations the speeds of adjustment become .175 for the banks, .334 for the life insurance companies, .152 for the trust companies and .293 for the mortgage loan companies.

cent for banks and 77 per cent each for life insurance companies, trust companies and mortgage loan companies.[41]

B. Financial Institutions — Portfolio Size

Because the size of the investment portfolios held by financial institutions exerts a very significant influence on the volume of mortgage lending undertaken by the financial institutions examined here, a brief description of the factors affecting the size of these portfolios is in order. This discussion, which is quite cursory, is presented only as an indication of some of the forces affecting asset size and not as a complete specification of these forces.[42]

My model is based upon the premise that the size of an institution's investment portfolio or total asset holdings (A^i) is determined by the public's willingness to hold the obligations of the institution, and that this essentially depends upon the public's wealth (W) (represented as an eight-quarter distributed lag on current-dollar gross national expenditure calculated by a first degree Almon variable), the yield offered by an institution on its obligations (R_i) relative to the yield offered on competing securities (R_j), and the public's existing holdings of the institution's obligations.[43]

$$A^i = f\ (R_i,\ R_j,\ W,\ A^i_{t-1}) \qquad (29)$$

This basic relationship, with the dependent variable expressed in first difference form (ΔA^i), was estimated for the change in asset holdings of the chartered banks, trust companies, mortgage loan companies, and twelve life insurance companies. In addition,

[41]These results are derived by dividing the stock adjustment coefficient (γ) into the coefficient on the total asset variable for each institution.

[42]A more rigorous and comprehensive model is now under development at the Bank of Canada in conjunction with the RDX project.

[43]An important determinant of the asset size of deposit taking institutions, the ease or convenience of dealing with them (i.e., accessibility, hours of operation, staff co-operation, etc. [40], pp. 327-335) has been ignored in this study because of difficulties in specification and data collection.

an insurance policy loan equation was estimated since policy loans arise in response to borrower actions and constitute a drain on life insurance company resources. Because the public's ability to obtain policy loans is a function of their insurance in force, which is assumed to vary with life company assets, life company assets rather than wealth are used in the policy loan regression. These regressions in untransformed and transformed form are presented in Table 3.

The regressions in Table 3 indicate that the model provides a reasonable explanation of the asset size of deposit-taking institutions and of the policy loans of life insurance companies, but unfortunately the model does not explain too well the asset size of life insurance companies. The change in chartered bank asset holdings depends upon the public's wealth and holdings of bank liabilities, the differential between the rate paid on chartered bank personal savings accounts and the short-term government bond rate (RPS - R03), and the differential between the rate paid on 90-day bank deposit receipts and the short-term bond rate (R90 - R03). The change in trust company asset holdings depends upon the public's wealth and holdings of trust company liabilities, the yield differential between the rate paid on trust and mortgage loan company one-year term liabilities and the short-term government bond rate (R1GIC - R03), and the differential between the trust and loan company chequable deposit rate and the chartered bank personal savings deposit rate (RCH - RPS). The change in mortgage loan company asset holdings depends upon the public's wealth, the differential between the rate on trust and mortgage loan company 5-year-term liabilities and the long-term government bond rate (R5GIC - RLC), and the differential between the chequable deposit rate and the chartered bank personal savings rate (RCH - RPS), although these variables are not highly significant. Hence, it appears from these results that the asset size of a deposit-taking institution depends upon the public's wealth, the public's existing holdings of an institution's obligations, and the rate paid on these obligations relative to the rate on alternative securities. However, my model does not provide a completely satisfactory explanation of the asset growth of financial institutions, since important non-price factors are ignored, i.e., location, convenience and services offered by these institutions.

Table 3

CHANGES IN ASSET HOLDINGS (ΔA) OF CANADIAN FINANCIAL INSTITUTIONS

	Constant	Q1	Q2	Q3	W	TBA_{t-1}	AT_{t-1}	AM_{t-1}	AL
Chartered Bank Assets	-147.3 (.89)	-170.6 (2.14)	70.9 (.91)	-140.3 (1.79)	.349 (3.07)	-.192 (2.35)			
	-119.5 (.94)	-188.6 (2.04)	50.2 (.71)	-165.5 (1.80)	.318 (3.73)	-.171 (2.79)			
Trust Company Assets	-455.6 (3.25)	129.0 (6.06)	53.4 (2.47)	23.4 (1.10)	.047 (2.39)		-.075 (1.56)		
	-478.0 (3.21)	128.4 (6.25)	53.9 (2.49)	23.0 (1.12)	.050 (2.38)		-.083 (1.64)		
Mortgage Loan Company Assets	-177.1 (1.70)	27.1 (1.90)	9.2 (.64)	9.9 (.69)	.018 (1.18)			-.010 (.18)	
	-169.2 (1.67)	27.3 (1.89)	9.1 (.64)	10.1 (.70)	.017 (1.14)			-.005 (.09)	
Life Insurance Company Policy Loans	8.0 (3.15)	.6 (1.25)	1.6 (2.77)	1.7 (3.00)					.0029 (2.82)
	12.2 (3.34)	.7 (1.91)	1.6 (3.92)	1.8 (4.94)					

(RPS - R03)$_{t-1}$	(R90 - R03)	(R1GIC - R03)	(R5GIC - RLC)	(RCH - RPS)$_{t-1}$	RLC$_{t-1}$	R^2	$\bar{R}^2$	SEE	D/W	ρ	Estimation Period
220.80 (5.07)	565.33 (3.29)					.64	.56	175.34	2.39		1Q55 - 4Q65
227.69 (6.91)	408.36 (2.88)							168.58	1.92	-.329	
		59.73 (2.83)		206.06 (2.03)		.68	.56	49.22	1.79		1Q55 - 4Q65
		60.15 (2.77)		218.23 (2.09)				49.12	1.90	.073	
			20.36 (.72)	89.89 (1.36)		.57	.56	32.84	1.97		1Q55 - 4Q65
			20.11 (.72)	84.39 (1.29)				32.83	1.90	-.037	
					4.09 (5.57)	.52	.46	1.38	.94		1Q54 - 4Q65
					4.89 (5.18)			1.12	2.04	.553	

The model operates reasonably well in explaining the policy loan holdings of life companies. The change in policy loan holdings varies with the size of life insurance companies' assets, the public's existing policy loans and the long-term government bond rate. Because the policy loan borrowing rate was fixed at 6 per cent it was not included in the specification.

Unfortunately, my stock adjustment model does not provide a good representation of the asset growth of life insurance companies, since the stock adjustment coefficient has the wrong sign, indicating a speed of adjustment exceeding 1. Consequently, a more or less ad hoc specification, presented in equation (30), was adopted for the asset growth of life insurance companies in which their assets vary directly with the public's wealth and inversely with the rate of change of the price level ($\dot{PGNE}$) and the short-term government bond rate (R03).

1Q54-4Q65

$$\underset{(1.86)}{AL = 6138.1} + \underset{(2.19)}{135.5\ Q1} + \underset{(2.35)}{142.9\ Q2} - \underset{(.07)}{3.9\ Q3} + \underset{(54.76)}{.81\ W}$$

$$- \underset{(2.12)}{6991.3\ \dot{PGNE}_{t-1}} - \underset{(2.07)}{57.8\ R03_{t-1}} \qquad (30)$$

SEE = 145.2 $\qquad R^2 = .99 \qquad \bar{\bar{R}}^2 = .99 \qquad$ D/W = .31

Surprisingly, a Hildreth/Lu autoregressive transformation yields a minimum $\rho = -.028$ despite the presence of serially correlated residuals indicated by an extremely low Durbin/Watson statistic. Therefore, to deal with this problem equation (30) was re-estimated in first-difference form in equation (31).

$$\underset{(8.95)}{\Delta\ AL = 72.2} + \underset{(4.48)}{48.3\ Q1} - \underset{(.46)}{4.0\ Q2} - \underset{(4.46)}{54.9\ Q3} + \underset{(5.79)}{.24\ \Delta\ W}$$

$$- \underset{(.59)}{198.96\ \Delta\ \dot{PGNE}_{t-1}} - \underset{(1.39)}{8.62\ \Delta\ R03_{t-1}} \qquad (31)$$

SEE = 21.1 $\qquad R^2 = .49 \qquad \bar{\bar{R}}^2 = .45 \qquad$ D/W = .90

4. A DISAGGREGATED HOUSING MARKET MODEL[44]

In this part of the paper the basic RDX1 housing sector is expanded to take account of the fact that the housing market is not really a single market in the classical sense but a series of overlapping submarkets differentiated by location, type, age and quality of dwelling, and kind of tenure (see [14], p. 135). Since each submarket is influenced by different institutional considerations and since the behaviour of the participants in these submarkets often differs substantially, it is desirable to disaggregate the housing market as much as possible. A start toward this disaggregation is made here by recognizing that the housing market is split fundamentally into two basic subsectors — the single dwelling sector primarily owner-occupied and the multiple dwelling sector primarily tenant-occupied — and by examining the behaviour of the participants in each of these sectors separately.

An indication of the differences between single and multiple dwelling sectors may be seen in Table 4, where the number of single and multiple unit housing starts and the percentage change in rents, Multiple Listing Service (MLS) sale prices, and NHA house prices since 1951 are presented. As one can see in Table 4, single and multiple dwelling starts followed distinct patterns over the period, showed different cyclical behaviour and grew at quite different rates. During this time multiple dwelling starts rose from less than 25 per cent of total housing starts in the early 1950's to approximately 50 per cent of total starts in the mid-1960's. Over the same period rents, prices of new NHA houses, and the average price of units sold through the Multiple Listing Service of real estate boards showed quite distinct cyclical patterns. However, after 1956, the period for which data are available for all categories, the average annual rate of inflation in these categories was quite similar, being 4.4 per cent for rents, 4.1 per cent for the prices of new NHA houses, and 5.0 per cent for MLS prices.

[44]Much of the work presented in this section is based upon an earlier paper by the author [42].

Table 4

SINGLE AND MULTIPLE HOUSING STARTS,
AND PERCENTAGE CHANGES IN HOUSING PRICES AND MONTHLY RENTS

Year	Housing starts, in thousands: Single*	Multiple*	Multiple starts as a percentage of total starts	Percentage change in: Average rents**	NHA prices*	MLS prices***
1951	53.0	15.6	22.7	12.1	n.a.	n.a.
1952	60.7	21.5	26.2	8.7	7.1	n.a.
1953	70.8	51.6	42.2	7.2	3.1	n.a.
1954	78.6	34.9	30.7	9.9	6.8	n.a.
1955	99.0	39.3	28.4	3.0	7.1	n.a.
1956	90.6	36.7	28.8	6.1	10.7	3.5
1957	83.0	39.3	32.1	4.4	7.9	8.1
1958	104.5	60.1	36.5	7.1	-.9	5.0
1959	92.9	48.4	34.3	.9	1.7	3.3
1960	67.2	41.7	38.3	3.4	-1.0	1.4
1961	76.4	49.2	39.2	2.1	.7	-2.6
1962	74.4	55.5	42.7	3.7	2.2	3.3
1963	77.2	71.4	48.0	2.3	2.8	-3.1
1964	77.1	88.6	53.5	4.1	4.0	8.2
1965	75.4	91.2	54.7	5.2	4.5	8.5
1966	70.6	63.9	44.2	5.9	8.6	9.5
1967	72.5	91.6	55.8	7.7	8.1	9.9
1968	75.3	121.6	61.8	3.8	4.2	11.0

Sources: * Central Mortgage and Housing Corporation: *Canadian Housing Statistics 1968*. Ottawa, March 1969, pp. 7 and 56.

** Dominion Bureau of Statistics: *Labour Force Survey* worksheets.

*** Canadian Association of Real Estate Boards: *The Canadian Realtor*, Toronto. Monthly.

n.a. — not available.

A. Residential Construction Expenditure and Housing Starts

The first benefits of disaggregation appear in my explanation of residential construction expenditure since I can now explicitly recognize that single and multiple dwelling starts generate different expenditures and different expenditure patterns.[45] This is accomplished by formulating residential construction expenditure as a function of lagged single (HSS) and multiple (HSM) housing starts in equations (32) and (32').

1Q54-4Q65

$$\underset{}{IRC} = \underset{(2.88)}{55.07} + \underset{(13.87)}{6.55}\ HSS + \underset{(6.22)}{2.89}\ HSS_{t-1} + \underset{(4.07)}{1.98}\ HSS_{t-2} + \underset{(3.65)}{2.72}\ HSM$$

$$+ \underset{(1.66)}{1.39}\ HSM_{t-1} + \underset{(1.19)}{.95}\ HSM_{t-2} + \underset{(1.82)}{1.14}\ HSM_{t-3} \qquad (32)$$

$$SEE = 15.94 \qquad R^2 = .95 \qquad D/W = 1.55$$

$$IRC = \underset{(2.20)}{48.62} + \underset{(14.05)}{6.71}\ HSS + \underset{(6.62)}{2.91}\ HSS_{t-1} + \underset{(4.39)}{2.06}\ HSS_{t-2} + \underset{(3.86)}{2.68}\ HSM$$

$$+ \underset{(1.97)}{1.46}\ HSM_{t-1} + \underset{(1.32)}{.95}\ HSM_{t-2} + \underset{(1.80)}{1.17}\ HSM_{t-3} \qquad (32')$$

$$SEE = 15.50 \qquad \rho = .228 \qquad D/W = 2.02$$

These equations are statistically superior and economically much more meaningful than the disaggregated equations presented in section 2 since equations (32) and (32') allow for variable expenditure patterns (single dwelling residential construction expenditure is spread over three quarters and multiple dwelling expenditure over four quarters), and for a separate estimate of the expenditures generated by each form of construction. Single dwelling starts are shown to generate construction expenditure

[45]This is recognized in D.B.S. calculations of residential construction expenditure by assigning different weights to single and multiple dwelling units put in place.

of approximately $11,550 per unit start in constant 1957 dollars while multiple dwelling starts are shown to generate expenditure of approximately $6,250 per unit start.[46] These figures compare to an over-all average of $7,500 per unit start indicated by the disaggregated equation. Finally, equations (32) and (32') have the statistical advantages of a substantially reduced standard error of estimate and a much smaller likelihood of serial correlation [16]. Consequently, it can readily be seen that this formulation is much more realistic and conveys substantially more meaningful information than that provided in the aggregate formulation presented in equation (2).

Once differences have been recognized in the price behaviour and pattern of single and multiple housing starts these differences should be incorporated into the model by analyzing the factors influencing the volume of single and multiple housing starts and the determination of prices in each of these sectors separately. In the remainder of this subsection I deal with the forces influencing the volume of housing starts in each sector.

Developers of multiple unit projects plan either to sell their buildings when they have been constructed and rented or to retain them as long-term investments. Thus the desirability of undertaking a multiple dwelling project depends upon the relationship between its expected selling price and its total construction cost, or upon the developer's expected yield on invested capital. Because real estate investments, like other long-term investments, are usually made on a yield basis, the desirability of a project from either the sale or revenue viewpoint is determined by the net cash flow, the amount of mortgage finance obtainable, and the construction and land costs associated with the project. Since the net cash flow depends upon gross rental income, interest costs, taxes and other current expenses and the amortization term of the mortgage, the volume of new multiple dwelling construction will be greatly influenced by existing rent levels, vacancy rates, construction and land costs and the terms and availability of mortgage credit.

An analysis of single unit construction introduces a new complication since these houses are not only speculatively built

[46]The average of the sum of the untransformed and transformed coefficients.

by merchant builders (developers) for subsequent sale but are also custom built by owner builders or contractors on a pre-sale basis (see [39], p. 58). When the demand for owner-occupancy dwellings increases, the price of single family dwellings increases relative to construction costs, assuming that increased building activity does not profoundly affect construction costs in the same period, and the speed at which houses are sold accelerates, thus causing an increase in the volume of new construction by merchant builders. Similarly, the greater the demand for owner-occupancy dwellings the greater will be the volume of construction of new custom-built houses. However, since the increased building of custom-built houses is not a consequence of the selling price to construction cost relationship, the forces influencing the level of this form of construction differ somewhat from those influencing the level of speculative building.

The role of mortgage credit in the single dwelling sector is more complex than in the multiple dwelling sector because mortgage credit has a more direct influence on the final demand for single dwellings. Merchant builders are influenced directly by the availability of mortgage credit since they require these funds for construction and indirectly because their houses will be difficult to sell if the cost and non-price terms of this credit are too stringent for prospective purchasers to absorb. Similarly, more stringent borrowing terms will reduce the volume of custom building by making monthly carrying costs and downpayment requirements or both, too burdensome for some prospective purchasers to absorb. Therefore, the volume of new single dwelling construction will be quite sensitive to the level of housing prices, vacancy rates, construction and land costs, and the terms and availability of mortgage credit.

Finally, when considering factors influencing the volume of single and multiple housing starts one must also take into account the possibility of substituting one type of construction for the other. This is partially done in my model by having single housing starts as a function of housing prices and multiple housing starts as a function of rents so that, ceteris paribus, if rents increase relative to housing prices, multiple housing starts will increase relative to single housing starts. Similarly, if developers think higher borrowing costs can be passed on to purchasers of single family houses more easily than to tenants in multiple

dwellings, rising mortgage rates will cause multiple dwelling construction to fall more sharply than single dwelling construction. In addition to these variables, land costs play an important role in determining the form of construction to be undertaken since rising land costs encourage higher density land utilization. This should lead to an increase in the volume of multiple dwelling construction relative to single dwelling construction. Although increasing land costs will also tend to discourage both forms of construction by reducing their profitability,[47] the net impact of rising land costs is likely to be an increase in multiple housing starts and a reduction in single housing starts.

From the above discussion it follows that multiple housing starts (HSM) are a function of rents (R), vacancy rates (V), construction costs (CC), land costs (L), and the cost (RM) and availability of private (MT) and public (CMHC) mortgage credit. Single dwelling housing starts (HSS) are a function of these same variables, except that the price of houses (PH) replaces rents, and land costs have the opposite influence in the single and multiple equations.

$$HSM = f\ (R, VM, CC, L, RM, MT, CMHCM) \qquad (33)$$

$$HSS = g\ (PH, VS, CC, L, RM, MT, CMHCS) \qquad (34)$$

The estimated equations for multiple and single housing starts are presented in equations (35) and (35') after deleting the vacancy variable, substituting a proxy credit rationing variable (RM - RB), and introducing the winter house-building incentive dummy variable (WW), as discussed in section 2.

[47]If prices and rents in period t depend upon the demand for and supply of housing units in t, increased land costs in t will have little or no effect on prices and rents in t. To the extent that increased costs reduce construction in t, they will restrain the increase in housing units in t+1, thereby raising prices and rents in t+1. However, unless prices and rents immediately react strongly to changes in the rate of growth of new housing units and unless the elasticity of demand for housing with respect to prices and rents is considerably less than 1, the profitability of such construction falls.

1Q57-4Q65

$$HSS = \underset{(1.76)}{32.5} - \underset{(7.33)}{12.0}\ Q1 + \underset{(4.72)}{8.3}\ Q2 + \underset{(4.51)}{6.3}\ Q3 + \underset{(2.83)}{7.1}\ WW + \underset{(1.13)}{31.01}\ (PH/CC)_{t-1}$$

$$- \underset{(2.14)}{.21}\ L - \underset{(2.28)}{5.41}\ RM_{t-1} + \underset{(3.63)}{6.18}\ (RM - RB)_{t-1} + \underset{(1.57)}{.028}\ \left(\frac{CMHCS}{PH}\right)$$

$$+ \underset{(4.34)}{.066}\ \left(\frac{CMHCS}{PH}\right)_{t-1} \qquad (35)$$

SEE = 2.48 $\quad R^2 = .93 \quad \bar{\bar{R}}^2 = .75 \quad$ D/W = 2.11

$$HSS = \underset{(1.74)}{33.4} - \underset{(7.49)}{12.0}\ Q1 + \underset{(4.72)}{8.3}\ Q2 + \underset{(4.56)}{6.3}\ Q3 + \underset{(2.91)}{7.2}\ WW + \underset{(1.21)}{33.10}\ (PH/CC)_{t-1}$$

$$- \underset{(2.23)}{.22}\ L - \underset{(2.29)}{5.67}\ RM_{t-1} + \underset{(3.48)}{6.13}\ (RM - RB)_{t-1} + \underset{(1.51)}{.027}\ \left(\frac{CMHCS}{PH}\right)$$

$$+ \underset{(4.36)}{.066}\ \left(\frac{CMHCS}{PH}\right)_{t-1} \qquad (35')$$

SEE = 2.48 $\quad \rho = .052 \quad$ D/W = 2.20

1Q57-4Q65

$$HSM = \underset{(.59)}{5.3} - \underset{(5.85)}{6.7}\ Q1 + \underset{(1.53)}{1.8}\ Q2 + \underset{(2.91)}{3.1}\ Q3 + \underset{(1.13)}{2.4}\ WW + \underset{(2.37)}{24.09}\ (R/CC)_{t-1}$$

$$+ \underset{(2.38)}{.16}\ L - \underset{(4.48)}{5.77}\ RM_{t-1} + \underset{(.05)}{.08}\ (RM - RB)_{t-1} + \underset{(1.96)}{.112}\ \left(\frac{CMHCM}{PH}\right)$$

$$+ \underset{(.38)}{.020}\ \left(\frac{CMHCM}{PH}\right)_{t-1} \qquad (36)$$

SEE = 2.37 $\quad R^2 = .89 \quad \bar{\bar{R}}^2 = .83 \quad$ D/W = 1.75

$$HSM = \underset{(.51)}{5.2} - \underset{(6.42)}{6.8}\ Q1 + \underset{(1.44)}{1.7}\ Q2 + \underset{(2.94)}{3.0}\ Q3 + \underset{(1.05)}{2.2}\ WW + \underset{(2.23)}{24.26}\ (R/CC)_{t-1}$$

$$+ \underset{(2.24)}{.16}\ L - \underset{(3.92)}{5.70}\ RM_{t-1} + \underset{(.01)}{.01}\ (RM - RB)_{t-1} + \underset{(1.84)}{.104}\ \left(\frac{CMHCM}{PH}\right)$$

$$+ \underset{(.23)}{.012}\ \left(\frac{CMHCM}{PH}\right)_{t-1} \qquad (36')$$

SEE = 2.35 $\rho = .149$ D/W = 1.95

These regressions reconfirm the appropriateness of my model and accentuate the distinctions between the single and multiple dwelling sectors. Single housing starts are significantly influenced by both the cost and the availability of private mortgage credit while only the cost of this credit influences the volume of multiple housing starts. Although these results are somewhat more pronounced than I had anticipated, they are consistent with the preceding discussion since developers of multiple dwellings are likely to be quite sensitive to interest costs that substantially affect the profitability and cash flow of their projects. On the other hand, builders of single dwellings are building for home purchasers who are accustomed to the high cost of consumer credit, who are primarily concerned with monthly and downpayment requirements, which are quite sensitive to variations in non-price lending terms (see [18], pp. 69-75), and who can vary the proportion of their budget devoted to housing. Consequently, these builders are less responsive to interest cost variations, as the elasticity measured at the means of -1.56 for single housing starts as opposed to -2.85 for multiple housing starts indicates, and require non-price credit rationing to equilibrate their sector of the market. Moreover, financial institutions are less likely to ration developers of multiple dwelling projects, who can be 'locked in' to financing for a longer period and whose goodwill the institutions covet, than small builders prevalent in the construction of single unit dwellings.[48] The significance of the government direct lending

[48]Individual, as opposed to corporate, borrowers have the legal right to discharge NHA mortgages after three years and conventional mortgages after five years on penalty of paying three months' interest. Corporate borrowers have no such privilege and therefore can be 'locked in' for the full term of their mortgages while individual borrowers cannot. Hence, in periods of high interest rates lending institutions prefer corporate to individual borrowers since corporate borrowers cannot repay their loans in advance if interest rates decline.

variable (CMHC) in the multiple equation is not inconsistent with the lack of private rationing in this sector, since Central Mortgage and Housing Corporation lending occurs at a lower rate than that charged for government insured mortgages.

The larger sum of the coefficients on the multiple variable than on the single government direct lending variable indicates that an additional million dollars of government mortgage lending in constant 1957 dollars for multiple dwellings will generate 40 per cent more dwelling starts than if this lending were for single dwelling construction. Land costs are shown to play a vital role in the mix of single and multiple housing starts as rising land costs significantly increase multiple housing starts at the expense of single housing starts, and have a net negative effect (although this net effect may not be significant). While the rent to construction cost ratio is quite significant in the multiple housing starts equation, the ratio of housing prices to construction costs is only significant at the 13 per cent confidence level (using a one-tailed test) in the single housing starts equation. This lower significance can partially be explained by the inappropriateness of the ratio in explaining housing starts for the large number of custom-built houses included in the single housing starts category. Finally, as expected, the winter house-building incentive programme had a much more pronounced effect on single housing starts than on multiple housing starts, where its impact was confined to multiple dwellings of two to four units.[49]

B. Prices and Rents

Although the general forces underlying the demand for rental and owner-occupancy dwellings are essentially the same (see section 2 for an elaboration of these forces), they have somewhat different effects on the participants in these markets. Net family formation, net immigration and net non-family household formation initially tend to generate demand for rental accommodation, while families experiencing first and second child births and families with fathers aged twenty-five to thirty-five often shift their demand from rental to owner-occupancy accommodation (see

[49]In this study multiple dwellings include duplexes, semi-detached and row houses and apartment units.

[9], p. 68). Recently, completing the life-cycle pattern, there has been a tendency for families to move back to rental from owner-occupancy accommodation following the departure of the children from the family home. In determining the demand for single vis-à-vis multiple dwelling units these demographic influences are extremely important. However, they are very elusive to specify, and consequently are reflected in my statistical work simply by expressing the demand for single dwellings on a per family basis (because families are the main occupiers of single dwellings), and by expressing the demand for units in multiple dwellings on a per capita basis (because the occupancy of these units is not confined to families and lack of non-family household data precludes a more structural specification). Numerous attempts were made to introduce child birth, migration and various age composition variables into the model but these attempts were generally unsuccessful despite their theoretical importance.

Variations in incomes also have different sectoral impacts on the demand for housing since variations in income not only influence over-all demand for housing by affecting net family undoubling, net family formation and net new non-family household formation (as discussed in section 2), but they also affect the allocation of demand between different kinds of housing. Ignoring qualitative effects, higher incomes enable more families to afford the monthly carrying costs and downpayments required for home ownership, thereby increasing the demand for single family dwellings. At the same time higher incomes enable more population units to afford the rents required to maintain separate living accommodation, thereby generating a net increase in the demand for rental accommodation despite the fact that rising incomes also enable families to shift some demand from rental to owner-occupancy dwellings. When assessing the relative strengths of these forces for the future it is interesting to note that between 1951 and 1966 the number of doubled families in Canada declined by approximately 140,000 (from 9.8 per cent to 4.0 per cent of all families), while the number of non-family households (60 per cent of which consist of individuals over 55 years) rose by over 382,000 (see [28], p. 40).[50]

[50]For comparative purposes it is interesting to note that the number of family households in Canada rose by approximately 1,230,000 between 1951 and 1966 ([10], p. 73), so that undoubling and net non-family household formation accounted for 30 per cent of the realized increase in housing demand.

As mentioned briefly in section 2, credit variables have a strong influence on the demand for housing accommodation by affecting the downpayment and monthly payment requirements associated with buying a home. However, if one ignores qualitative effects, as is done in this study, the main impact of credit influences is on the allocation of final housing demand between rental and owner accommodation rather than on the over-all user demand for housing. Although more stringent credit terms reduce the demand for owner-occupancy housing there is no corresponding net reduction in the over-all demand for housing since much of this reduced demand for owner-occupancy housing is shifted to rental accommodation. This happens because more stringent credit terms cause families to delay their shift from rental to owner-occupancy dwellings and to undouble into rental rather than into owner-occupancy accommodation causing a net increase in the demand for rental accommodation. Hence, although more stringent credit terms reduce over-all housing demand to some extent, the most pronounced effect is the shifting of demand for owner-occupancy housing to rental housing. Thus, more stringent credit terms are likely to cause a net reduction in the demand for owner-occupancy dwellings and a net increase in the demand for rental accommodation.

This discussion can now be summarized in functional form and its validity tested by regression analysis. Per capita demand for units in multiple dwellings (DHM/POPT) depends upon permanent real per capita disposable income (YDP/POPT), the price of houses (PH) and the rent on multiple dwelling units (R), the price of alternative goods and services (PGNE), and the cost (RM) and availability (MT) of mortgage credit. Family demand for single dwellings (DHS/HH) depends upon these same variables with permanent real family disposable income (YDP/HH) replacing (YDP/POPT), and with the credit, rent and housing price variables exerting an influence on the demand for single family dwellings opposite to the influence of these variables on the demand for multiple accommodation.

$$DHM/POPT = h\ (YDP/POPT,\ PH,\ R,\ PGNE,\ RM,\ MT) \qquad (37)$$

$$DHS/HH = k\ (YDP/HH,\ PH,\ R,\ PGNE,\ RM,\ MT) \qquad (38)$$

Rents and housing prices can now be determined by introducing the per family stock of single dwellings (SHS/HH) and per capita

stock of multiple dwellings (SHM/POPT), and interacting these stocks with their respective demand functions.

$$R = r\ (YDP/POPT,\ PH,\ PGNE,\ RM,\ MT,\ SHM/POPT) \qquad (39)$$

$$PH = p\ (YDP/HH,\ R,\ PGNE,\ RM,\ MT,\ SHS/HH) \qquad (40)$$

Since the stock of dwelling units existing in any period is equal to the stock of the previous period plus completions and conversions less removals and demolitions; if conversions, removals and demolitions are a function of past stock, and completions a function of lagged housing starts, the supply of each type of housing is a function of the previous stock and lagged starts.

$$(SHM/POPT) = j\ [(SHM/POPT)_{t-1},\ \sum_{i=0}^{n} \beta_i\ (HSM/POPT)_{t-i}] \qquad (41)$$

$$(SHS/HH) = q\ [(SHS/HH)_{t-1},\ \sum_{i=0}^{m} \beta_i\ (HSS/HH)_{t-i}] \qquad (42)$$

Estimates of equations (39) to (42), with the stock of rental (SHR) and owner-occupancy (SHO) dwellings replacing the stock of multiple (SHM) and single (SHS) dwellings (because sectoral housing stock estimates are available only in the latter form), are presented in equations (43) to (48). The coefficients of the lagged housing start variables in equations (47) and (48) were estimated by the Almon technique using second and third degree Almon variables.[51]

[51] The actual estimated housing stock regressions are:

$$SHO = \underset{(982.59)}{.9989}\ SHO_{t-1} + \underset{(5.51)}{3.88}\ Z_2^s - \underset{(4.55)}{2.80}\ Z_3^s$$

$R^2 = .99$ $\qquad$ D/W = 2.23

$$SHR = \underset{(979.44)}{.9995}\ SHR_{t-1} + \underset{(3.67)}{3.14}\ Z_2^m - \underset{(2.90)}{2.34}\ Z_3^m$$

$R^2 = .99$ $\qquad$ D/W = 2.06

where Z_2^s and Z_3^s are second and third degree Almon variables created on single housing starts and Z_2^m and Z_3^m are second and third degree Almon variables created on multiple housing starts.

1Q57-4Q65

$$\text{PH} = \underset{(1.84)}{141.5} + \underset{(.90)}{.9}\,\text{Q1} + \underset{(3.58)}{3.5}\,\text{Q2} + \underset{(1.79)}{1.7}\,\text{Q3} + \underset{(.96)}{19.12}\,(\text{YDP/HH})_{t-1} \tag{43}$$

$$- \underset{(2.43)}{305.09}\,(\text{SHO/HH}) + \underset{(2.75)}{1.34}\,\text{PGNE}_{t-1} + \underset{(.99)}{.29}\,\text{R}_{t-1} - \underset{(1.00)}{2.51}\,\text{RM}_{t-1}$$

SEE = 1.95 $\quad R^2 = .93 \quad \bar{\bar{R}}^2 = .92 \quad$ D/W = 1.15

$$\text{PH} = \underset{(1.55)}{133.3} + \underset{(.97)}{.7}\,\text{Q1} + \underset{(3.78)}{3.1}\,\text{Q2} + \underset{(2.46)}{1.7}\,\text{Q3} + \underset{(1.43)}{35.32}\,(\text{YDP/HH})_{t-1} \tag{43'}$$

$$- \underset{(1.72)}{255.84}\,(\text{SHO/HH}) + \underset{(1.57)}{.71}\,\text{PGNE}_{t-1} + \underset{(1.12)}{.35}\,\text{R}_{t-1} - \underset{(.32)}{.98}\,\text{RM}_{t-1}$$

SEE = 1.69 $\quad \rho = .425 \quad$ D/W = 1.40

1Q57-4Q65

$$\text{PH} = \underset{(1.95)}{149.4} + \underset{(1.08)}{1.0}\,\text{Q1} + \underset{(3.63)}{3.6}\,\text{Q2} + \underset{(1.97)}{1.8}\,\text{Q3} + \underset{(2.60)}{34.05}\,(\text{YDP/HH})_{t-1}$$

$$- \underset{(2.92)}{346.38}\,(\text{SHO/HH}) + \underset{(2.63)}{1.27}\,\text{PGNE}_{t-1} + \underset{(.73)}{.22}\,\text{R}_{t-1} \tag{44}$$

SEE = 1.95 $\quad R^2 = .93 \quad \bar{\bar{R}}^2 = .92 \quad$ D/W = 1.05

$$\text{PH} = \underset{(1.45)}{123.8} + \underset{(1.04)}{.7}\,\text{Q1} + \underset{(3.86)}{3.0}\,\text{Q2} + \underset{(2.72)}{1.7}\,\text{Q3} + \underset{(2.09)}{41.99}\,(\text{YDP/HH})_{t-1}$$

$$- \underset{(1.70)}{243.42}\,(\text{SHO/HH}) + \underset{(1.40)}{.60}\,\text{PGNE}_{t-1} + \underset{(1.03)}{.31}\,\text{R}_{t-1} \tag{44'}$$

SEE = 1.64 $\quad \rho = .475 \quad$ D/W = 1.42

1Q57-4Q65

$$R = \underset{(1.60)}{-54.4} + \underset{(3.67)}{245.36}\,(YDP/POPT)_{t-1} - \underset{(1.84)}{1096.18}\,(SHR/POPT)_{t-1}$$

$$+ \underset{(3.78)}{1.24}\,PGNE_{t-1} + \underset{(1.61)}{.25}\,PH_{t-1} + \underset{(1.88)}{2.88}\,RM_{t-1} \qquad (45)$$

SEE = 1.35 $\qquad R^2 = .98 \qquad$ D/W = 1.15

$$R = \underset{(1.49)}{-60.1} + \underset{(3.28)}{254.80}\,(YDP/POPT)_{t-1} - \underset{(1.03)}{769.15}\,(SHR/POPT)_{t-1}$$

$$+ \underset{(2.92)}{.90}\,PGNE_{t-1} + \underset{(2.13)}{.32}\,PH_{t-1} + \underset{(1.89)}{3.40}\,RM_{t-1} \qquad (45')$$

SEE = 1.21 $\qquad \rho = .425 \qquad$ D/W = 1.44

1Q57-4Q65

$$R = \underset{(1.06)}{-35.9} + \underset{(3.10)}{203.36}\,(YDP/POPT)_{t-1} - \underset{(2.30)}{1376.21}\,(SHR/POPT)_{t-1}$$

$$+ \underset{(5.93)}{1.61}\,PGNE_{t-1} + \underset{(1.43)}{.23}\,PH_{t-1} \qquad (46)$$

SEE = 1.41 $\qquad R^2 = .98 \qquad$ D/W = 1.24

$$R = \underset{(.89)}{-35.0} + \underset{(2.92)}{226.02}\,(YDP/POPT)_{t-1} - \underset{(1.45)}{1090.09}\,(SHR/POPT)_{t-1}$$

$$+ \underset{(4.21)}{1.22}\,PGNE_{t-1} + \underset{(1.97)}{.31}\,PH_{t-1} \qquad (46')$$

SEE = 1.27 $\qquad \rho = .375 \qquad$ D/W = 1.42

These price and rent regressions are quite consistent with those in section 2 and with themselves. (Housing prices and rents vary directly with permanent real disposable income, the price of competing housing, and the price of alternative goods and services; and inversely with the respective stocks of housing.) Housing prices seem to vary inversely with the cost of mortgage credit, and rents seem to vary directly with this cost, which is consistent with the notion that rising financing costs shift demand from owner to rental housing. However, the deletion of the mortgage cost variable in equations (44) and (46) seems to have little or no effect on the explanatory power of the regressions. The R^2's remain the same and the SEE rises slightly in only one case, while the deletion of the mortgage cost variable allows the income variable to become much more significant in the housing price regression. Therefore, although the mortgage rate variable performs as anticipated it does not appear to play a leading role in price and rent determination. On the other hand, it must be remembered that the price, rent and mortgage cost variables are all inexact representations of true market conditions, as previously discussed in section 2, and consequently the likelihood of a strong correlation is diminished in my specification. Demographic influences enter the specification since the variables in the price equation are expressed on a per family basis, and the variables in the rent equation are expressed on a per capita basis. In an effort to introduce more specific demographic variables numerous other specifications were attempted but they were generally unsatisfactory.

Since the Hildreth/Lu search procedure yielded autoregressive parameters greater than 1, a Theil/Nagar autoregressive transformation [52] was used in equations (43') to (46') in an unsuccessful attempt to eliminate serial correlation. These transformed regressions do not indicate any startling changes although they consistently increase the significance of the price of competing dwelling accommodation variables and reduce the significance of the alternative goods and services variable (PGNE). These regressions also tend generally to increase the importance of the effects of income on housing prices and to reduce slightly the effect of the existing housing stock.

2Q54-4Q65

$$SHO = \underset{(982.59)}{.9989}\ SHO_{t-1} + \underset{(4.14)}{.276}\ HSS + \underset{(7.43)}{.407}\ HSS_{t-1}$$

$$+ \underset{(6.36)}{.293}\ HSS_{t-2} + \underset{(5.81)}{.101}\ HSS_{t-3} \qquad (47)$$

SEE = 4.31 $\qquad$ R^2 = .99 $\qquad$ D/W = 2.23

2Q54-4Q65

$$SHR = \underset{(979.44)}{.9995}\ SHR_{t-1} + \underset{(1.79)}{.132}\ HSM + \underset{(7.55)}{.251}\ HSM_{t-1}$$

$$+ \underset{(5.15)}{.235}\ HSM_{t-2} + \underset{(4.28)}{.146}\ HSM_{t-3} + \underset{(3.89)}{.047}\ HSM_{t-4} \qquad (48)$$

SEE = 2.46 $\qquad$ R^2 = .99 $\qquad$ D/W = 2.06

Disaggregative housing stock regressions in equations (47) and (48) are also quite consistent with the total stock regression in section 2. The existing stock of owner-occupied and rental accommodation is determined by the amount of each form of accommodation that existed in the previous period and current housing completions, where current housing completions are represented by past housing starts. The lagged housing stock coefficient of less than 1 indicates that demolitions and removals exceed conversions, since these were all assumed to be a function of lagged stock. Coefficients on the lagged housing start variables indicate an average construction period of approximately two and one-quarter quarters for multiple dwelling projects and one and two-thirds quarters for single housing units.[52] The fact that the sum of the coefficients of the multiple housing start variables is considerably below 1 and that the sum of the coefficients of the single housing start variables is above 1 arises from classification inconsistencies inherent in the use of SHR and SHO as

[52]The average construction period was calculated after adjusting the lagged start coefficients so that all housing starts give rise to housing completions.

approximations for SHM and SHS, respectively. These results indicate that not all multiple dwellings, which include duplexes and row housing, are used for rental purposes. Finally, the Hildreth/Lu transformations confirm the absence of serial correlation, yielding ρ's of -.112 and -.026 in the SHO and SHR regressions, respectively, and transformed coefficients virtually identical to those in the untransformed regressions.

C. Construction Costs

Because land costs enter the disaggregated housing start equations separately, my construction cost variable was redefined in this section to exclude land cost. The measure of construction cost (CC) in this section is an index of the average cost of construction (excluding land cost) per square foot on new government-insured single detached dwellings. Variations in this index were assumed to be influenced by the same variables as in section 2, part C, with the exception of land costs, i.e., by changes in average hourly earnings in construction (WC), changes in temporary or bridge financing costs (R03), changes in the cost of building materials and the cost of delays and bottlenecks that arise as current residential construction (IRC) and non-residential construction (INRC) press against their respective industrial capacities. Changes in the cost of building materials, along with the cost of delays and bottlenecks are represented by deviations of current residential and non-residential construction from their seasonally adjusted logarithmic trends and a sales tax dummy variable (DVST). This estimated construction cost regression in untransformed and transformed form is presented in equations (49) and (49').

3Q55-4Q65

$$\ln CC - \ln CC_{t-4} = \underset{(1.59)}{-.0064} + \underset{(2.74)}{.041} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(5.27)}{.097} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(2.61)}{.239} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(3.78)}{.027} (\ln R03 - \ln R03_{t-4}) + \underset{(7.17)}{.034} DVST \tag{49}$$

SEE = .011 R^2 = .86 D/W = 1.39

$$\ln CC - \ln CC_{t-4} = \underset{(.92)}{-.0052} + \underset{(2.28)}{.044} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.43)}{.066} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.83)}{.198} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(3.66)}{.028} (\ln R03 - \ln R03_{t-4}) + \underset{(5.48)}{.035} DVST \tag{49'}$$

SEE = .010 ρ = .466 D/W = 1.91

These equations indicate that construction costs are influenced by the same variables, with the exception of land costs, as construction and land costs in section 2. Moreover, the coefficients on these variables are remarkably similar to those in the construction and land cost equations (14) and (15). The only exception is the variable for average hourly earnings in construction (WC), which has a much stronger impact on construction costs in equations (49) and (49') when multicollinearity is reduced by the exclusion of land costs, than in equations (14) and (15).

5. SUMMARY OF FUNCTIONAL RELATIONSHIPS AND ESTIMATED EQUATIONS

Before turning to the simulations in the next section it is useful for reference purposes to summarize the functional relationships and estimated ordinary least squares equations of the preceding four sections.

A. The Housing and Mortgage Sectors of RDX1

1. Functional Relationships:

$$IRC = f\left(\sum_{i=0}^{m} \beta_i \, HST_{t-i}\right) \tag{50}$$

$$HST = h\,(PH/CLC,\ RM,\ RM - RB,\ CMHC,\ WW) \tag{51}$$

$$PH = p\,(YDP/HH,\ STH/HH,\ PGNE) \tag{52}$$

$$STH = s\left(\sum_{i=0}^{n} \beta_i \, HST_{t-i},\ STH_{t-1}\right) \tag{53}$$

$$\dot{CLC} = c\,(INRC/\widehat{INRC},\ IRC/\widehat{IRC},\ \dot{WC},\ \dot{L},\ R\dot{0}3,\ DVST) \tag{54}$$

$$L = l\,(POPT,\ YDP,\ STH,\ \Delta\ L) \tag{55}$$

$$RC = r\,(RB,\ RNHA,\ YDP/HH,\ STH/HH,\ ALTM,\ MLTM) \tag{56}$$

$$RM \equiv (RC + RNHA)/2 \tag{57}$$

2. Ordinary Least Squares Estimates:

Investment in residential construction

$$\underset{(6.62)}{IRC = 117.15} + \underset{(16.96)}{4.62\ HST} + \underset{(7.69)}{1.96\ HST_{t-1}} + \underset{(3.32)}{.92\ HST_{t-2}} \tag{58}$$

$R^2 = .89$ $\qquad$ $D/W = 1.05$

Total housing starts

$$\text{HST} = \underset{(1.06)}{25.6} - \underset{(9.26)}{20.2}\ \text{Q1} + \underset{(3.86)}{7.7}\ \text{Q2} + \underset{(4.13)}{7.7}\ \text{Q3} + \underset{(2.76)}{9.5}\ \text{WW} + \underset{(3.75)}{76.80}\ (\text{PH/CLC}) \tag{59}$$

$$- \underset{(4.32)}{12.58}\ \text{RM}_{t-1} + \underset{(2.35)}{5.20}\ (\text{RM} - \text{RB})_{t-1} + \underset{(1.44)}{.029}\ \left(\frac{\text{CMHC}}{\text{PH}}\right) + \underset{(3.93)}{.058}\ \left(\frac{\text{CMHC}}{\text{PH}}\right)_{t-1}$$

$R^2 = .95$ D/W = 1.95

Price of houses

$$\text{PH} = \underset{(1.70)}{74.1} + \underset{(1.10)}{1.1}\ \text{Q1} + \underset{(3.44)}{3.8}\ \text{Q2} + \underset{(2.03)}{2.0}\ \text{Q3} + \underset{(2.95)}{57.13}\ (\text{YDP/HH})_{t-1}$$

$$- \underset{(2.40)}{180.89}\ (\text{STH/HH}) + \underset{(3.94)}{1.44}\ \text{PGNE}_{t-1} \tag{60}$$

$R^2 = .92$ D/W = .97

Total stock of housing units

$$\text{STH} = \underset{(680.78)}{.9997}\ \text{STH}_{t-1} + \underset{(2.85)}{.224}\ \text{HST} + \underset{(5.07)}{.372}\ \text{HST}_{t-1}$$

$$+ \underset{(4.69)}{.275}\ \text{HST}_{t-2} + \underset{(4.44)}{.096}\ \text{HST}_{t-3} \tag{61}$$

$R^2 = .99$ D/W = 2.03

Construction costs (including land costs)

$$\ln \text{CLC} - \ln \text{CLC}_{t-4} = \underset{(.51)}{-.0031} + \underset{(1.92)}{.039}\ (\ln \text{INRC} - \ln \widehat{\text{INRC}})_{t-1}$$

$$+ \underset{(3.81)}{.090}\ (\ln \text{IRC} - \ln \widehat{\text{IRC}})_{t-1} + \underset{(1.13)}{.13}\ (\ln \text{WC} - \ln \text{WC}_{t-4})$$

$$+ .11 \underset{(2.58)}{} (\ln L - \ln L_{t-4}) + \underset{(3.30)}{.030} (\ln RO3 - \ln RO3_{t-4})$$

$$+ \underset{(5.11)}{.029} \; DVST \qquad (62)$$

$R^2 = .78$ $\qquad$ D/W = 1.56

Land costs

$$L = \underset{(5.81)}{-141.5} + \underset{(6.55)}{.042} \; POPT + \underset{(4.38)}{.030} \; YDP - \underset{(5.09)}{.15} \; STH + \underset{(5.08)}{.59} \; \Delta L \qquad (63)$$

$R^2 = .96$ $\qquad$ D/W = .77

Conventional mortgage rate

$$RC = \underset{(3.20)}{9.7} - \underset{(2.95)}{8.85} \; (STH/HH)_{t-1} + \underset{(3.16)}{3.17} \; (YDP/HH) - \underset{(6.02)}{.0031} \; ALTM$$

$$+ \underset{(5.76)}{.0045} \; MLTM_{t-1} + \underset{(4.49)}{.38} \; RNHA + \underset{(4.49)}{.32} \; RB_{t-1} \qquad (64)$$

$R^2 = .96$ $\qquad$ D/W = 1.14

B. The Mortgage Sector of RDX1 Extended

1. Functional Relationships:

$$MA^i = m \; (RM - RB, A^i, M^i_{t-1}) \qquad (65)$$

$$\Delta A^i = a \; (W, A^i_{t-1}, R_i - R_j) \qquad (66)$$

2. Ordinary Least Squares Estimates:

The financial institution mortgage approval regressions are presented together in Table 1 and the net asset growth or inflow regressions are presented in Table 3 and in equation (30).

C. The Disaggregated Housing Model

1. Functional Relationships:

$$IRC = e\left(\sum_{i=0}^{n} \beta_i \, HSS_{t-i}, \; \sum_{j=0}^{m} \beta_j \, HSM_{t-j}\right) \tag{67}$$

$$HSS = n\,(PH/CC,\ L,\ RM,\ RM - RB,\ CMHCS,\ WW) \tag{68}$$

$$HSM = q\,(R/CC,\ L,\ RM,\ RM - RB,\ CMHCM,\ WW) \tag{69}$$

$$PH = b\,(YDP/HH,\ SHO/HH,\ R,\ PGNE,\ RM) \tag{70}$$

$$R = d\,(YDP/POPT,\ SHR/POPT,\ PH,\ PGNE,\ RM) \tag{71}$$

$$SHO = k\left(\sum_{i=0}^{n} \beta_i \, HSS_{t-i},\ SHO_{t-1}\right) \tag{72}$$

$$SHR = g\left(\sum_{j=0}^{m} \beta_j \, HSM_{t-j},\ SHR_{t-1}\right) \tag{73}$$

$$\dot{CC} = z\,(INRC/\widehat{INRC},\ IRC/\widehat{IRC},\ \dot{WC},\ \dot{R}03,\ DVST) \tag{74}$$

Other equations are the same as in RDX1 and the extended mortgage market sector.

2. Ordinary Least Squares Estimates:

Investment in residential construction

$$IRC = \underset{(2.88)}{55.07} + \underset{(13.87)}{6.55}\ HSS + \underset{(6.22)}{2.89}\ HSS_{t-1} + \underset{(4.07)}{1.98}\ HSS_{t-2}$$

$$+ \underset{(3.65)}{2.72}\, HSM + \underset{(1.66)}{1.39}\, HSM_{t-1} + \underset{(1.19)}{.95}\, HSM_{t-2} + \underset{(1.82)}{1.14}\, HSM_{t-3} \quad (75)$$

$R^2 = .95$ $\qquad$ $D/W = 1.55$

Single housing starts

$$HSS = \underset{(1.76)}{32.5} - \underset{(7.33)}{12.0}\, Q1 + \underset{(4.72)}{8.3}\, Q2 + \underset{(4.51)}{6.3}\, Q3 + \underset{(2.83)}{7.1}\, WW$$

$$+ \underset{(1.13)}{31.01}\, (PH/CC)_{t-1} - \underset{(2.14)}{.21}\, L - \underset{(2.28)}{5.41}\, RM_{t-1}$$

$$+ \underset{(3.63)}{6.18}\, (RM - RB)_{t-1} + \underset{(1.57)}{.028} \left(\frac{CMHCS}{PH}\right)$$

$$+ \underset{(4.34)}{.066} \left(\frac{CMHCS}{PH}\right)_{t-1} \quad (76)$$

$R^2 = .93$ $\qquad$ $D/W = 2.11$

Multiple housing starts

$$HSM = \underset{(.59)}{5.3} - \underset{(5.85)}{6.7}\, Q1 + \underset{(1.53)}{1.8}\, Q2 + \underset{(2.91)}{3.1}\, Q3 + \underset{(1.13)}{2.4}\, WW + \underset{(2.37)}{24.09}\, (R/CC)_{t-1}$$

$$+ \underset{(2.38)}{.16}\, L - \underset{(4.48)}{5.77}\, RM_{t-1} + \underset{(.05)}{.08}\, (RM - RB)_{t-1}$$

$$+ \underset{(1.96)}{.112} \left(\frac{CMHCM}{PH}\right) + \underset{(.38)}{.020} \left(\frac{CMHCM}{PH}\right)_{t-1} \quad (77)$$

$R^2 = .89$ $\qquad$ $D/W = 1.75$

Price of houses

$$(78)$$

$$PH = \underset{(1.84)}{141.5} + \underset{(.90)}{.9}\, Q1 + \underset{(3.58)}{3.5}\, Q2 + \underset{(1.79)}{1.7}\, Q3 + \underset{(.96)}{19.12}\, (YDP/HH)_{t-1}$$

$$- \underset{(2.43)}{305.09} (SHO/HH) + \underset{(2.75)}{1.34} PGNE_{t-1} + \underset{(.99)}{.29} R_{t-1} - \underset{(1.00)}{2.51} RM_{t-1}$$

$R^2 = .93$ D/W = 1.15

Rent

$$R = \underset{(1.60)}{-54.4} + \underset{(3.67)}{245.36} (YDP/POPT)_{t-1} - \underset{(1.84)}{1096.18} (SHR/POPT)_{t-1}$$

$$+ \underset{(3.78)}{1.24} PGNE_{t-1} + \underset{(1.61)}{.25} PH_{t-1} + \underset{(1.88)}{2.88} RM_{t-1} \qquad (79)$$

$R^2 = .98$ D/W = 1.15

Stock of owner-occupied housing units

$$SHO = \underset{(982.59)}{.9989} SHO_{t-1} + \underset{(4.14)}{.276} HSS + \underset{(7.43)}{.407} HSS_{t-1}$$

$$+ \underset{(6.36)}{.293} HSS_{t-2} + \underset{(5.81)}{.101} HSS_{t-3} \qquad (80)$$

$R^2 = .99$ D/W = 2.23

Stock of renter-occupied housing units

$$SHR = \underset{(979.44)}{.9999} SHR_{t-1} + \underset{(1.79)}{.132} HSM + \underset{(7.55)}{.251} HSM_{t-1}$$

$$+ \underset{(5.15)}{.235} HSM_{t-2} + \underset{(4.28)}{.146} HSM_{t-3} + \underset{(3.89)}{.047} HSM_{t-4} \qquad (81)$$

$R^2 = .99$ D/W = 2.06

Construction costs

$$\ln CC - \ln CC_{t-4} = \underset{(1.59)}{-.0064} + \underset{(2.74)}{.041} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(5.27)}{.097} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(2.61)}{.239} (\ln WC - \ln WC_{t-4})$$

$$+ .027 \underset{(3.78)}{(\ln R03 - \ln R03_{t-4})} + \underset{(7.17)}{.034} \text{ DVST} \qquad (82)$$

$R^2 = .86$ D/W = 1.39

6. SIMULATIONS OF THE RDX1 HOUSING AND EXTENDED HOUSING MODELS

In order to examine the stability and predictability of my models and to explore the impact of alternative policy measures on the housing market, a number of simulations of the RDX1 housing and extended housing models were conducted. These simulations consist of first: solutions for both models over the twelve-quarter period 1963-1965 within the estimation period, and over the eight-quarter period 1966-1967 beyond the estimation period, and second: solutions for both models over the twelve-quarter period 1963-1965 after introducing various policy changes such as a 1 per cent increase in the long-term government bond rate, a 1 per cent increase in the NHA mortgage rate, and a $100 million increase in CMHC direct mortgage lending.

A. The Basic Simulations

The first simulations were solutions for the RDX1 housing and extended housing sector models over the twelve-quarter period 1Q63-4Q65, initializing in 4Q62; and solutions for these models for the eight quarters immediately beyond the estimation period 1Q66-4Q67, initializing in 4Q65. Thus simulations were begun in 4Q62 and 4Q65, respectively, with the actual values of the lagged endogenous variables. Thereafter internally generated values were used.

The endogenous variables in the RDX1 version simulations are housing starts (HST), residential construction expenditure (IRC), construction and land costs (CLC), housing prices (PH), the stock of housing units (STH), and the conventional mortgage rate (RC). These variables are determined by equations (50) to (54), and (56).

The endogenous variables in the extended housing model simulations are: single housing starts (HSS), multiple housing starts (HSM), residential construction expenditure (IRC), construction costs (CC), housing prices (PH), rents (R), the stock of owner-occupied houses (SHO) and renter-occupied houses (SHR) and the conventional mortgage rate (RC). These variables are determined by equations (67) to (73), and (56). The exogenous variables in the simulations of both models are: families (HH), population (POPT), permanent real disposable income (YDP), the size of financial institutions' assets (ALTM), financial institutions' mortgage holdings (MLTM), the implicit private gross national expenditure deflator (PGNE), non-residential construction expenditure (INRC), average hourly earnings in construction (WC), and land costs (L). The exogenous policy variables in both models are: the long-term government bond rate (RLC), the short-term government bond rate (R03), the NHA mortgage rate (RNHA), and the volume of Central Mortgage and Housing Corporation direct lending (CMHC). In the disaggregate model the latter variable is replaced by two variables, the volume of Central Mortgage and Housing Corporation lending on single dwellings (CMHCS) and the volume of CMHC lending on multiple dwellings (CMHCM).[53]

In Table 5 I present the results of the twelve-quarter simulation within, and the eight-quarter simulation beyond, the estimation period in terms of the percentage error of the predictions for each of the endogenous variables in the RDX1 housing model. The results for the endogenous variables in the extended housing model are presented in Table 6. The two solutions are compared with the actual values for residential construction expenditure and total housing starts (single and multiple unit starts are combined) in Diagram 2 and Diagram 3.

These simulation results demonstrate the stability of my specification within the estimation period, as only residential construction expenditure and housing starts have average percentage errors exceeding 2 per cent for the twelve-quarter simulation. Residential construction expenditure has an average percentage error of 4.7 per cent in the aggregate RDX1 model and of only 3.3 per cent in the extended disaggregated model. Housing starts have

[53]Because the simulations were conducted within the framework of the over-all RDX1 model [24] and because RLC rather than RB was used in RDX1, RLC was used in place of RB in my simulations.

Table 5

RESULTS OF SIMULATIONS IN TERMS OF PERCENTAGE ERRORS*
FOR TWELVE QUARTERS (1Q63-4Q65) WITHIN, AND EIGHT QUARTERS
(1Q66-4Q67) BEYOND, THE ESTIMATION PERIOD USING THE RDX1 HOUSING MODEL

Period	IRC	HST	PH	CLC	STH	RC
1963-1965	%	%	%	%	%	%
1	-11.3	11.5	-4.0	1.8	-.1	.8
2	-4.5	-4.5	-2.8	.2	-.1	1.0
3	.6	6.0	-1.3	-.4	—	1.2
4	-6.7	-4.6	-3.5	—	-.1	-.5
5	6.4	-.3	-.6	.4	—	-.3
6	-8.7	-4.5	1.7	-.4	-.1	-1.7
7	-1.8	7.9	.7	-.4	-.1	-2.5
8	-.8	6.8	-1.1	.3	-.2	-3.8
9	.7	-5.3	.5	.8	-.1	.3
10	-3.5	7.1	2.9	-1.1	-.2	1.0
11	-2.8	7.3	2.4	-.3	-.3	3.4
12	-8.7	-10.7	1.8	.8	-.4	1.0
Average Twelve Quarters	4.7	6.4	1.9	.6	.1	1.5
1966-1967						
1	6.0	2.5	2.7	.5	-.1	.4
2	8.2	-9.1	1.4	-1.3	.1	-.5
3	-8.6	-20.7	2.3	3.1	.2	1.3
4	-11.8	-13.1	1.0	6.3	.1	-.4
5	-5.4	31.3	2.6	1.8	—	-1.5
6	6.6	15.8	1.0	2.6	.1	3.2
7	-7.5	-11.5	1.4	6.6	.1	6.1
8	-2.9	5.1	1.1	9.3	.1	4.2
Average Eight Quarters	7.1	13.6	1.7	3.9	.1	2.2

* - indicates that simulation estimate exceeds actual value.

Table 6

RESULTS OF SIMULATIONS IN TERMS OF PERCENTAGE ERRORS*
FOR TWELVE QUARTERS (1Q63-4Q65) WITHIN, AND EIGHT QUARTERS
(1Q66-4Q67) BEYOND, THE ESTIMATION PERIOD USING THE EXTENDED HOUSING MODEL

Period 1963-1965	IRC %	HSS %	HSM %	PH %	R %	CC %	SHO %	SHR %	RC %
1	.3	63.0	-35.2	-3.3	1.0	1.3	-.1	-.2	.8
2	3.1	-2.7	-11.0	-2.6	1.1	.6	-	-.3	1.0
3	3.1	-4.0	2.2	-1.0	1.5	-	.1	-.4	1.2
4	-4.6	-.2	-4.4	-2.6	-.8	-	-	-.5	-.5
5	6.8	1.5	-3.2	-.2	-.9	1.0	-.1	-.3	-.2
6	-7.0	-7.2	-10.0	1.6	-.6	.5	-	-.5	-1.5
7	1.6	-4.1	13.1	.7	.3	-.2	-	-.6	-2.3
8	2.8	2.2	14.9	-1.0	-.7	.3	-.1	-.7	-3.5
9	1.7	-3.6	-16.4	.1	.9	.5	-	-.4	.5
10	-5.2	-21.9	17.9	2.0	2.1	.1	-	-.3	1.0
11	.9	-1.3	17.6	1.9	1.5	.3	-	-.2	3.2
12	-2.7	.3	-12.2	1.7	-.6	1.3	-.1	-.1	.7
Average Twelve Quarters	3.3	9.3	13.1	1.6	1.0	.5	.1	.4	1.4
Average Eleven Quarters (2Q63-4Q65)		4.5	11.1						
1966-1967									
1	9.5	41.7	-38.3	3.0	-.7	-.1	-.1	.1	.3
2	12.9	7.9	-23.8	1.4	-1.5	-1.3	.1	.6	-.2
3	8.9	19.6	-35.8	2.2	-1.6	2.4	.3	.9	1.1
4	7.4	32.2	-45.1	1.0	-3.6	3.7	.4	1.2	-.8
5	15.3	124.2	-62.3	1.9	-2.2	2.0	.5	1.0	-2.4
6	13.6	11.8	12.7	-.1	-1.9	3.1	.7	1.0	2.3
7	-.2	-10.9	-14.8	-.1	-1.2	9.2	.8	.9	5.0
8	16.5	63.4	-4.6	-.4	-2.3	10.3	1.0	.9	3.2
Average Eight Quarters	10.5	38.9	29.7	1.3	1.9	4.0	.5	.8	1.9
Average Seven Quarters (ex. 1Q67)	9.9	26.7	25.0						

* - indicates that simulation exceeds actual value.

Diagram 2

SIMULATION RESULTS — RESIDENTIAL CONSTRUCTION EXPENDITURE

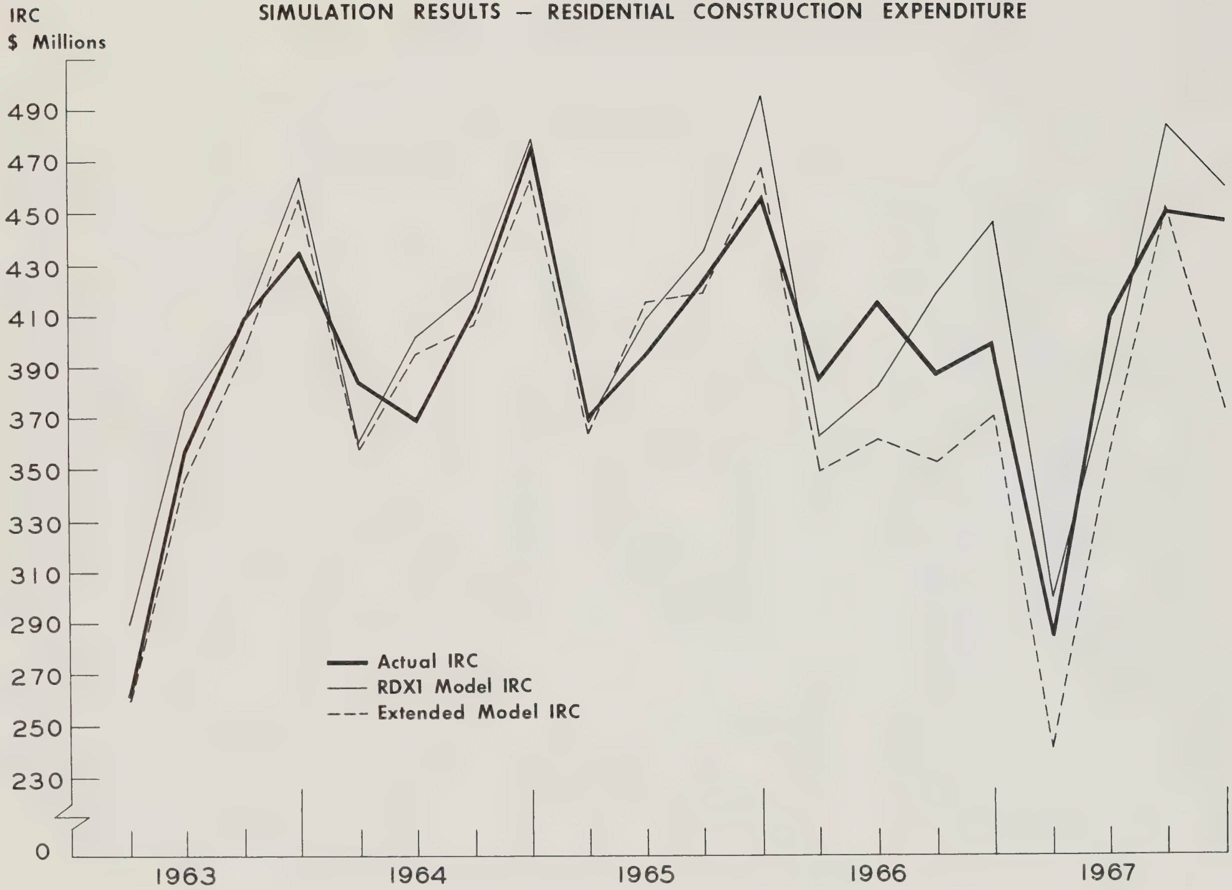
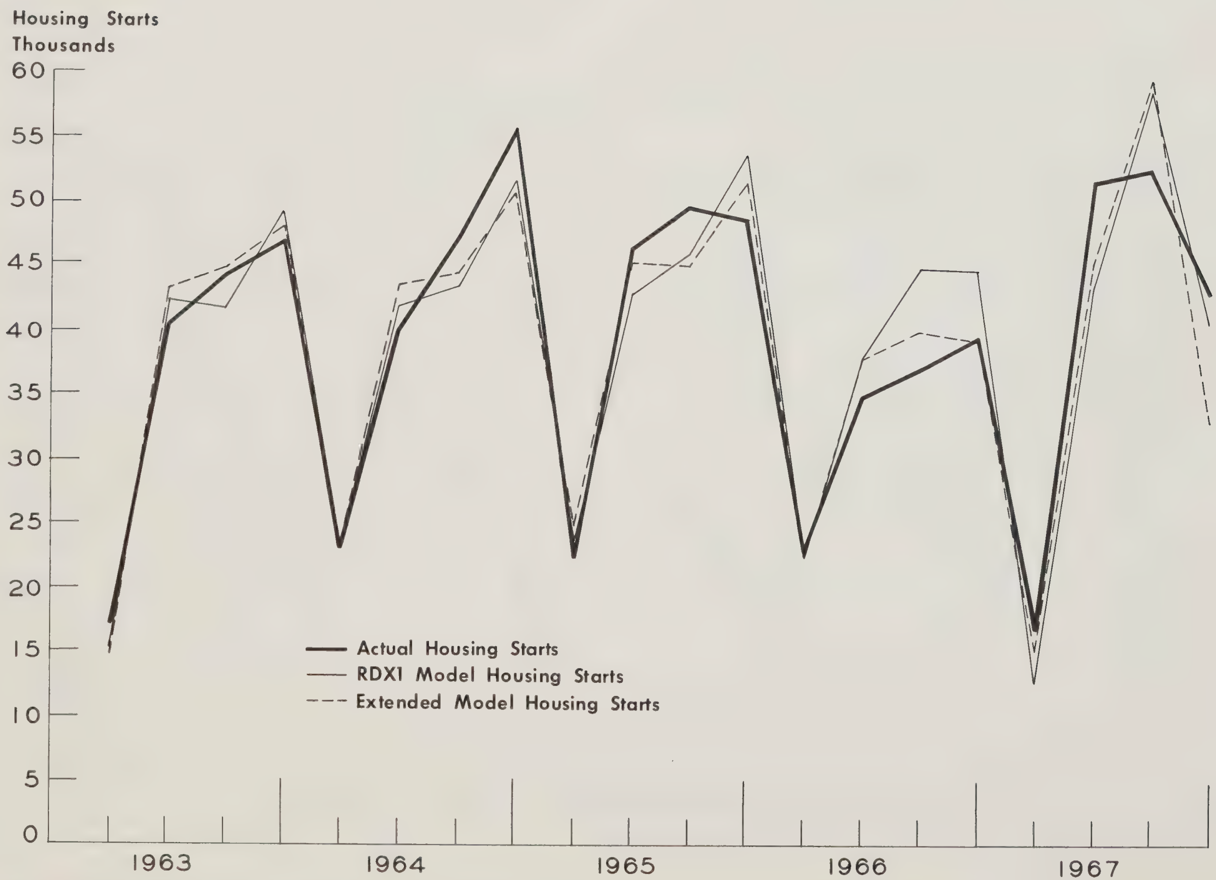


Diagram 3

SIMULATION RESULTS — HOUSING STARTS



an average percentage error of 6.4 per cent in the aggregate formulation, and of 9.3 per cent for single and 13.1 per cent for multiple starts in the disaggregated formulation. However, if one ignores the first quarter (1Q63), which simulates surprisingly poorly considering that most variables take their original values, the average percentage error for single housing starts in the eleven-quarter period (2Q63-4Q65) declines to 4.5 per cent and for multiple housing starts to 11.1 per cent. Housing prices, rents, construction costs and the conventional mortgage rate all simulate extremely well in both models, with average percentage errors from .5 per cent for construction costs, to 1.5 per cent for the conventional mortgage rate, and to between 1.0 per cent and 1.9 per cent for the price and rent variables.

The simulation results for the eight quarters beyond the estimation period are less impressive than those obtained for the twelve quarters within the estimation period. This is particularly true in the disaggregated model where the division between single and multiple starts simulates poorly, although their sum approximates total starts reasonably well. The poor results when single and multiple starts are taken separately seem to originate from a structural shift in the impact of land costs, probably arising from their extremely rapid rate of increase, since a comparison of the land cost coefficients in the single and multiple housing start regressions for the estimation period ending 4Q65 (equations (33) and (34)) with those for the estimation period ending 4Q67 (Appendix B, equations (B-9) and (B-10)) reveals a 50 per cent decline in both land cost coefficients. Therefore, since land costs enter the single housing starts regression with too large a negative coefficient and enter the multiple housing starts regression with too large a positive coefficient, it is not surprising that the simulations underestimate single housing starts and overestimate multiple housing starts during the 1966-1967 period.

Nevertheless, considering the models in their entirety, the results are encouraging. In the aggregate model only IRC at 7.1 per cent and HST at 13.6 per cent have average percentage errors exceeding 4.0 per cent. As discussed below, this is not a bad performance for the housing market over the very volatile 1966-1967 period. Similarly, except for the single and multiple housing starts mix, which is quite unsatisfactory, the aggregate model fares rather well with only IRC at 10.5 per cent having an average percentage error exceeding 4.0 per cent.

However, a fair assessment of IRC and housing start simulation results cannot be made for the 1966-1967 period from the size of our percentage errors alone because of the very volatile performance of the housing market after 1965. Rather, any assessment should be made in conjunction with predictions generated by other procedures. Consequently, in order to facilitate such comparisons, residential construction expenditures and housing starts were forecast by two 'naive' mechanical procedures and their percentage errors compared with the simulated percentage errors in Tables 7 and 8. 'Naive procedure A' predicts that IRC and HST in any quarter will be the same as in the corresponding quarter of the previous year, i.e., $\hat{IRC} = IRC_{t-4}$. 'Naive procedure B' predicts that any change in IRC or HST between the corresponding quarters of the preceding two years will also occur in the current quarter, i.e., $\hat{IRC} = IRC_{t-4} + (IRC_{t-4} - IRC_{t-8})$.

These comparisons indicate that predictions arising from my models for residential construction expenditure and for total housing starts substantially outperform those made by 'naive' mechanical forecasting procedures. For residential construction expenditure, the average quarterly percentage error arising from simulation predictions using the RDX1 housing model is 7.1 per cent and from using the extended housing model is 10.5 per cent, compared to 11.7 per cent using 'naive procedure A' and 15.3 per cent using 'naive procedure B'.

For total housing starts the average quarterly percentage error arising from simulation predictions using the RDX1 model is 14.4 per cent. In the extended housing model, using the sum of single and multiple starts, the error is 11.0 per cent. These errors compare to 24.5 per cent using 'naive procedure A' and 34.6 per cent using 'naive procedure B'. However, in the case of separate predictions for single and multiple housing starts arising from simulations of the extended housing model, only the predictions of multiple housing starts outperform 'naive procedures A and B'. Multiple housing starts have an average quarterly percentage error of 29.7 per cent compared to average errors of 35.7 per cent and 47.8 per cent for 'naive procedures A and B', respectively. In the case of single dwelling starts my simulations have an average error of 39.0 per cent compared with 24.2 per cent and 28.5 per cent for 'naive procedures A and B'.

Table 7

COMPARISON OF PERCENTAGE ERRORS* IN
PREDICTIONS OF RESIDENTIAL CONSTRUCTION EXPENDITURE

Predictions Arising From:

Quarter		Procedure A	Procedure B	RDX1 Housing Sector Simulations	RDX1 Extended Housing Sector Simulations
		%	%	%	%
1966	1	3.9	7.5	6.0	9.5
	2	4.8	-1.4	8.2	12.9
	3	-9.6	-12.2	-8.6	8.9
	4	-14.0	-9.0	-11.8	7.4
1967	1	-35.1	-40.4	-5.4	15.3
	2	1.5	-6.4	6.6	13.6
	3	14.2	22.4	-7.5	-.2
	4	10.7	23.3	-2.9	16.5
Average		11.7	15.3	7.1	10.5

* - indicates that simulation exceeds actual value.

Table 8

COMPARISON OF PERCENTAGE ERRORS* IN PREDICTIONS OF HOUSING STARTS

Quarter		Predictions Arising From: Procedure A	Procedure B	RDX1 Housing Sector Simulations	RDX1 Extended Housing Sector Simulations**
		%	%	%	%
1966	1	2.7	6.3	3.6	3.5
	2	-32.5	-50.0	-16.8	-8.6
	3	-33.4	-40.3	-23.8	-7.8
	4	-22.8	-5.4	-16.9	.5
1967	1	-35.0	-38.7	24.1	18.7
	2	32.6	54.5	13.2	12.4
	3	29.4	53.0	-10.6	-13.1
	4	7.8	28.8	5.9	23.1
Average		24.5	34.6	14.4	11.0

* - indicates that simulation exceeds actual value.

** Calculations based on sum of single and multiple starts.

B. Alternative Policy Simulations

In order to assess the implications of various policies designed to influence the volume of residential construction and other aspects of the housing market, my models were re-simulated over the 1963-1965 period after introducing separate one-shot changes in the NHA mortgage rate (up 1 per cent), in the long-term government bond rate (up 1 per cent), in both the NHA mortgage and long-term government bond rates (both up 1 per cent), and in the volume of Central Mortgage and Housing Corporation direct lending (up $100 million) during 1Q63. The percentage changes in housing starts and prices resulting from the introduction of each of these alternative policies into the housing sector of RDX1 are presented in Table 9. The percentage changes in single and multiple housing starts and prices and rents resulting from each of these policies in my disaggregate housing model are presented in Tables 10 and 11. The increase in CMHC direct lending in the disaggregate model was $50 million for both single and multiple housing.

These simulations have a number of interesting implications. According to the aggregate model, a 1 per cent increase in the long-term bond rate will cause a 6.6 per cent decline in housing starts in the first year (even though the increase in RLC has no effect on housing starts in the quarter in which the 1 per cent increase is introduced),[54] a 7.7 per cent decline in the second year and a 6.3 per cent decline in the third year. According to the disaggregate model a 1 per cent increase in RLC will generate a smaller reduction in housing starts than the aggregate model indicates and will shift the mix between single and multiple starts because single starts remain relatively constant (increasing slightly) while multiple starts decline by approximately 2.8 per cent each year. Housing prices are also affected by the change in RLC. The aggregate model indicates a 1.1 per cent increase after twelve quarters. The disaggregate model shows that this is the consequence of a slight increase in rents and a very slight reduction in house prices.

[54]The increases in interest rates referred to in this section are in absolute terms — i.e., an increase from 5.50 per cent to 6.50 per cent is a 1.0 per cent increase in interest rates, while the percentage changes in housing starts and rents in this section are in relative terms, i.e., an increase from 20,000 HST to 21,000 HST is a 5 per cent increase in housing starts.

Table 9

RESULTS OF SIMULATIONS UNDER ALTERNATIVE
POLICIES USING THE RDX1 HOUSING MODEL

Quarter		Change in housing starts, in thousands, arising from an increase in: RNHA	RLC	RNHA & RLC	CMHC	Percentage change in housing prices arising from an increase in: RNHA	RLC	RNHA & RLC	CMHC
1963	1	—	—	—	2.6	—	—	—	—
	2	-9.1	-2.6	-9.3	5.0	.1	—	.1	-.1
	3	-6.3	-3.7	-10.2	-.6	.3	.1	.4	-.2
	4	-5.6	-3.4	-9.1	-.3	.5	.2	.6	-.3
1964	1	-5.6	-3.4	-8.9	-.2	.8	.4	1.1	-.3
	2	-7.7	-3.2	-8.4	-.4	1.0	.5	1.2	-.3
	3	-4.4	-3.0	-7.8	-.5	1.2	.5	1.7	-.3
	4	-4.5	-2.8	-7.4	-.2	1.4	.7	1.9	-.3
1965	1	-4.8	-2.9	-7.7	-.1	1.6	.8	2.2	-.2
	2	-6.8	-2.6	-6.9	-.3	1.8	.8	2.4	-.2
	3	-3.2	-2.5	-6.3	-.5	1.8	.9	2.7	-.2
	4	-3.8	-2.4	-6.3	—	2.0	.11	2.9	-.2

Table 10

RESULTS OF SIMULATIONS FOR HOUSING STARTS UNDER ALTERNATIVE POLICIES USING THE DISAGGREGATE HOUSING MODEL

Quarter		Change in single housing starts, in thousands, arising from an increase in:				Change in multiple housing starts, in thousands, arising from an increase in:			
		RNHA	RLC	RNHA & RLC	CMHC	RNHA	RLC	RNHA & RLC	CMHC
1963	1	—	—	—	1.3	—	—	—	5.3
	2	—	—	.5	3.2	-4.6	-.1	-4.2	1.0
	3	—	.1	.2	-.3	-4.0	-.6	-4.7	-.3
	4	.3	—	.2	-.4	-3.6	-.7	-4.3	-.3
1964	1	.3	—	.3	-.2	-3.5	-.7	-4.3	-.1
	2	.3	—	.3	-.2	-3.5	-.6	-4.2	—
	3	.4	—	.4	-.4	-3.4	-.7	-4.1	-.2
	4	.5	—	.4	-.4	-3.4	-.7	-4.2	-.3
1965	1	.5	—	.5	-.2	-3.4	-.7	-4.1	-.2
	2	.4	—	.5	-.2	-3.3	-.6	-4.0	—
	3	.6	.1	.7	-.3	-3.3	-.7	-4.0	-.2
	4	.6	—	.6	-.4	-3.2	-.7	-3.9	-.3

Table 11

RESULTS OF SIMULATIONS FOR HOUSING PRICES AND RENTS UNDER ALTERNATIVE POLICIES USING THE DISAGGREGATE HOUSING MODEL

		Percentage change in housing prices arising from an increase in:				Percentage change in rents arising from an increase in:			
Quarter		RNHA	RLC	RNHA & RLC	CMHC	RNHA	RLC	RNHA & RLC	CMHC
1963	1	—	—	—	-.1	—	—	—	—
	2	-1.6	—	-1.8	-.1	1.8	—	2.1	—
	3	-1.3	-.4	-1.7	-.3	1.6	.4	2.2	-.1
	4	-1.2	-.3	-1.6	-.3	1.5	.3	2.1	-.2
1964	1	-1.2	-.3	-1.4	-.4	1.6	.3	2.3	-.3
	2	-1.1	-.3	-1.6	-.3	1.8	.3	2.5	-.3
	3	-1.0	-.3	-1.6	-.3	1.9	.4	2.7	-.3
	4	-1.0	-.3	-1.6	-.3	2.0	.4	2.9	-.3
965	1	-1.0	-.2	-1.5	-.3	2.2	.4	3.2	-.2
	2	-1.0	-.3	-1.5	-.3	2.3	.5	3.3	-.2
	3	-1.0	-.3	-1.5	-.2	2.3	.4	3.5	-.2
	4	-1.0	-.3	-1.5	-.2	2.4	.5	3.7	-.2

A 1 per cent increase in the NHA mortgage rate appears to have a more pronounced impact on the housing market than does a 1 per cent increase in the long-term bond rate. The aggregate model indicates that a 1 per cent increase in RNHA will cause a 14.2 per cent reduction in housing starts in the first year (even though the increase has no effect on housing starts during the quarter in which this increase is introduced), a 13.9 per cent reduction in the second year and an 11.1 per cent reduction in the third year. The disaggregated model indicates a 15.8 per cent reduction in multiple housing starts in the first year, a 16.6 per cent reduction in the second year and a 15.3 per cent reduction in the third year, compared to a .4 per cent increase in single housing starts in the first year, a 1.9 per cent increase in the second year and a 2.6 per cent increase in the third year arising from a 1 per cent increase in RNHA. Thus, once again, the disaggregate model indicates a smaller net reduction in housing starts than does the aggregate model. Prices are also more significantly influenced by a change in RNHA than by a change in RLC. The aggregate model shows a 2 per cent increase in housing prices after twelve quarters arising from a 1 per cent increase in RNHA compared to a 1.1 per cent increase in housing prices resulting from a 1 per cent increase in RLC. Once again this mortgage rate increase works to the detriment of tenants, as rents rise 2.4 per cent after twelve quarters, and to the benefit of home purchasers, as prices fall 1.0 per cent after twelve quarters.

An increase of $100 million in Central Mortgage and Housing Corporation direct lending generates an increase in housing starts in the first two quarters after this injection of additional funds and a slight reduction in housing starts thereafter. According to the aggregate model this increased lending will generate an additional 7,600 housing starts in the first two quarters but only an additional 4,400 starts over the first three years, since this government financed construction is partially offset by reduced privately financed activity. According to the disaggregate model an additional $50 million of single and multiple dwelling direct lending will generate an additional 4,500 single dwelling starts and 6,300 multiple dwelling starts in the first two quarters but only an additional 1,500 single starts and 4,400 multiple starts after three years. The total number of housing starts is higher in the disaggregate model because the lending mix has a larger multiple component than that implied by the coefficients in the

aggregate model. Both models indicate a very slight reduction in housing prices and rents. These simulation results are only partial, however, because no allowance is made for the impact an additional $100 million of government funding will have on the capital markets.

The highlights of the various policy alternatives are summarized in terms of annual elasticities in Tables 12 and 13, and in terms of their influence on residential construction expenditure in Diagrams 4 and 5. These summaries clearly demonstrate that variations in the NHA mortgage rate will more profoundly affect residential construction and housing prices than equivalent variations in the long-term government bond rate, although variations in both these rates will have a substantial impact on the volume and mix of residential construction and a minor impact on housing prices and rents. Variations in government direct mortgage lending activity will also have a significant effect on residential construction, initially stimulating and subsequently retarding slightly the volume of building activity.

CONCLUSION

In this paper I have attempted to specify and analyze the structure of, and the forces operating on and within, the housing and mortgage markets, and then to use the developed structure to examine the implications of alternative government policies. In a number of areas, however, this study is rudimentary raising many more questions than it answers, especially concerning the structure and interrelationships of the various components or subsectors of these markets.

A further cautionary word about using my results today (April 1970) must be issued because of the structural changes that have occurred since the study was started in 1967. Complete data were then available only to the end of 1965 and consequently the basic specification was determined on the basis of these data, although the model was later re-estimated making use of data to the end of 1967. Unfortunately for my purposes, the housing and mortgage markets have undergone profound structural changes since 1965

Table 12

A COMPARISON OF HOUSING START ELASTICITIES OVER TIME WITH RESPECT TO CHANGES IN THE NHA MORTGAGE RATE AND THE LONG-TERM GOVERNMENT BOND RATE

	RDX1 Model		Disaggregate Model			
	Total Housing Starts		Single Housing Starts		Multiple Housing Starts	
Year	RNHA	RLC	RNHA	RLC	RNHA	RLC
1	-.90	-.34	.03	.01	-1.00	-.09
2	-.87	-.40	.12	—	-1.04	-.17
3	-.69	-.33	.16	.01	-.96	-.16

Table 13

A COMPARISON OF PRICE AND RENT ELASTICITIES OVER TIME WITH RESPECT TO CHANGES IN THE NHA MORTGAGE RATE AND THE LONG-TERM GOVERNMENT BOND RATE

	RDX1 Model		Disaggregate Model			
	Housing Prices		Housing Prices		Rents	
Year	RNHA	RLC	RNHA	RLC	RNHA	RLC
1	.01	.01	-.08	-.01	.08	.01
2	.07	.03	-.07	-.02	.11	.02
3	.11	.05	-.06	-.02	.14	.02

Diagram 4

RESIDENTIAL CONSTRUCTION EXPENDITURE SIMULATIONS (AGGREGATE MODEL) UNDER ALTERNATIVE POLICY ASSUMPTIONS

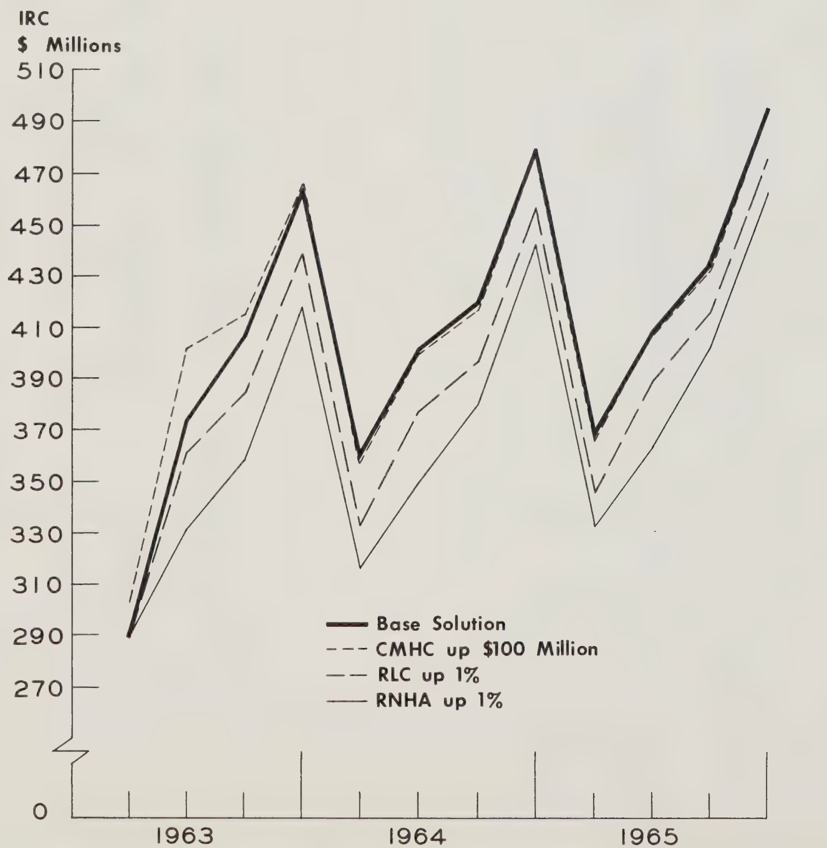
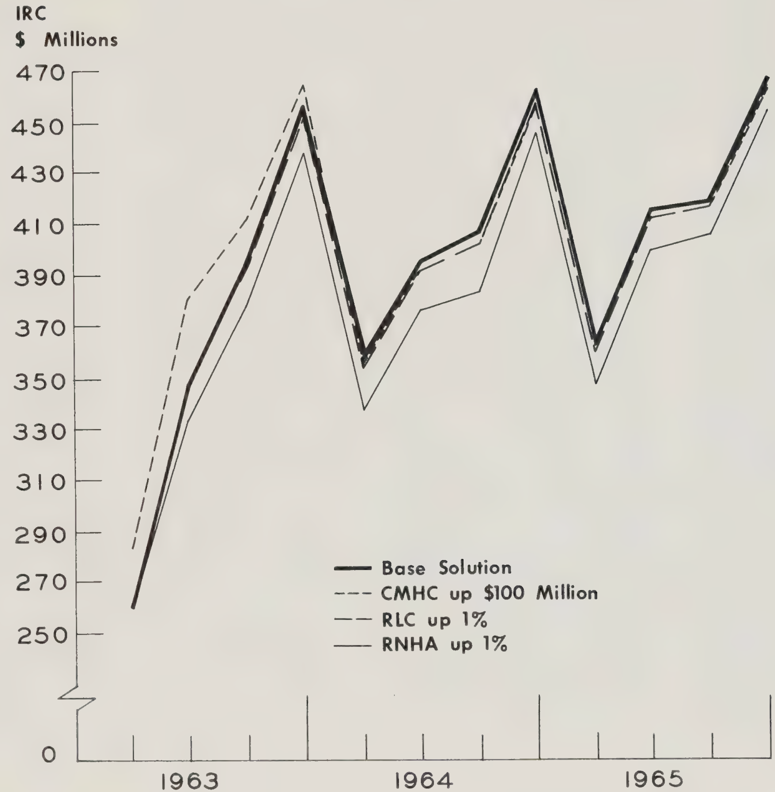


Diagram 5

RESIDENTIAL CONSTRUCTION EXPENDITURE SIMULATIONS (DISAGGREGATE MODEL) UNDER ALTERNATIVE POLICY ASSUMPTIONS



necessitating a reformulation of some of my specifications. For example, since 1965 the NHA mortgage interest rate evolved from a rate constrained by an arbitrarily set and seldom adjusted ceiling, to a rate constrained by a ceiling adjusted quarterly in relation to variations in the yield on long-term Government of Canada securities (the NHA ceiling was initially set at one and one-half per cent above the average long-term government yield in the previous quarter and then readjusted to two and one-quarter per cent above this yield), to a rate that was freed of all such constraints, and allowed to be determined in the market.

Even more important for the extrapolative use of the models, 1965 ushered in a highly inflationary period, which has lasted to the time of writing. During this period an inflationary psychology arose that has had a pronounced effect on the reactions of real estate developers to monetary considerations, especially in the case of the construction of multiple dwellings. Essentially, the expectation of sharply rising costs induces developers to undertake new projects in the face of rising interest costs because developers expect that delay will mean higher land and construction costs, and that any possible saving in financing costs will be more than offset by increases in other costs. Consequently, price expectations, which were less important during the basic estimation period, must now be incorporated into the model. Similarly, the distinction between real and nominal interest rates becomes much more important in periods of rising prices and it is possible, and probably quite likely, that a re-specification of the model in terms of real rather than nominal interest rates would be very beneficial where the estimation period is extended.

Despite these difficulties the basic model presented bears a reasonable resemblance to the real world and works well both over the original estimation period and the period extended to the end of 1967. Therefore, it is hoped that this work will serve as a guide to, and a framework for, further explorations in these most diverse and complex markets.

APPENDIX A

Two-Stage Estimates of the RDX1 Housing Sector

In this appendix I present two-stage Fisherian estimates of the basic RDX1 housing sector over an estimation period ending in 4Q65.

A-1 Investment in residential construction, 1Q54-4Q65

$$IRC = \underset{(6.56)}{117.9} + \underset{(16.42)}{4.60}\ HST + \underset{(7.70)}{1.96}\ HST_{t-1} + \underset{(3.29)}{.92}\ HST_{t-2}$$

SEE = 22.06 R^2 = .89 D/W = 1.05

A-2 Total housing starts, thousands of units, 1Q57-4Q65

$$HST = \underset{(.55)}{17.2} - \underset{(8.62)}{20.2}\ Q1 + \underset{(3.65)}{7.8}\ Q2 + \underset{(3.72)}{7.5}\ Q3 + \underset{(2.34)}{8.7}\ WW$$

$$+ \underset{(3.37)}{90.73}\ (PH/CLC) - \underset{(3.96)}{12.55}\ RM_{t-1} + \underset{(1.50)}{3.24}\ (RM - RB)_{t-1}$$

$$+ \underset{(1.40)}{.031} \left(\frac{CMHC}{PH}\right) + \underset{(3.65)}{.058} \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 3.55 R^2 = .92 D/W = 1.83

A-3 Price of houses, 1Q57-4Q65

$$PH = \underset{(1.95)}{79.1} + \underset{(1.49)}{1.5}\ Q1 + \underset{(3.98)}{4.1}\ Q2 + \underset{(2.22)}{2.1}\ Q3 + \underset{(3.05)}{55.62}\ (YDP/HH)_{t-1}$$

$$- \underset{(2.99)}{212.3}\ (STH/HH) + \underset{(4.82)}{1.74}\ PGNE_{t-1}$$

SEE = 1.92 R^2 = .91 D/W = 1.14

A-4 Total stock of housing units, 2Q54-4Q65

$$STH = \underset{(651.6)}{.9993}\ STH_{t-1} + \underset{(2.49)}{.202}\ HST + \underset{(5.25)}{.406}\ HST_{t-1} + \underset{(4.99)}{.310}\ HST_{t-2}$$

$$+ \underset{(4.78)}{.110}\ HST_{t-3}$$

$SEE = 6.66$ $\quad$ $R^2 = .999$ $\quad$ $D/W = 2.02$

A-5 Construction costs (including land costs), 3Q55-4Q65

$$\ln CLC - \ln CLC_{t-4} = \underset{(.49)}{-.0032} + \underset{(1.90)}{.045}\ (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.45)}{.085}\ (\ln IRC - \ln \widehat{IRC})_{t-1}$$

$$+ \underset{(.63)}{.078}\ (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.26)}{.125}\ (\ln L - \ln L_{t-4})$$

$$+ \underset{(3.40)}{.038}\ (\ln R03 - \ln R03_{t-4}) + \underset{(5.15)}{.030}\ DVST$$

$SEE = .014$ $\quad$ $R^2 = .74$ $\quad$ $D/W = 1.52$

APPENDIX B

Ordinary Least Squares Regressions of the RDX1 Housing and the Extended Housing Models — Estimation Period Extended to the End of 1967

In this appendix I present ordinary least squares re-estimates, untransformed and transformed, of the basic and extended RDX1 models over an estimation period extended to the end of 1967.

A. The RDX1 Housing Model

B-1 Investment in residential construction, 1Q54-4Q67

$$IRC = \underset{(7.11)}{119.28} + \underset{(17.91)}{4.56}\ HST + \underset{(7.83)}{1.86}\ HST_{t-1} + \underset{(3.91)}{1.01}\ HST_{t-2}$$

SEE = 22.28 $\qquad R^2 = .88 \qquad$ D/W = 1.06

B-1'

$$IRC = \underset{(5.42)}{95.39} + \underset{(22.98)}{4.90}\ HST + \underset{(9.66)}{2.00}\ HST_{t-1} + \underset{(5.56)}{1.18}\ HST_{t-2}$$

SEE = 19.60 $\qquad \rho = .499 \qquad$ D/W = 2.04

B-2 Total housing starts, 1Q57-4Q67

$$HST = \underset{(.50)}{9.7} - \underset{(9.93)}{20.7}\ Q1 + \underset{(3.21)}{6.7}\ Q2 + \underset{(2.96)}{6.0}\ Q3 + \underset{(2.53)}{8.75}\ WW$$

$$+ \underset{(2.92)}{64.41}\ (PH/CLC) - \underset{(3.17)}{8.78}\ RM_{t-1} + \underset{(2.02)}{5.41}\ (RM - RB)_{t-1}$$

$$+ \underset{(2.33)}{.032} \left(\frac{CMHC}{PH}\right) + \underset{(4.27)}{.054} \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 4.05 $\quad$ R^2 = .92 $\quad$ D/W = 1.59

B-2'

$$HST = \underset{(.43)}{10.6} - \underset{(11.43)}{20.2}\, Q1 + \underset{(2.91)}{5.8}\, Q2 + \underset{(3.00)}{5.3}\, Q3 + \underset{(2.24)}{6.91}\, WW$$

$$+ \underset{(2.33)}{68.42}\, (PH/CLC) - \underset{(2.51)}{8.58}\, RM_{t-1} + \underset{(1.54)}{4.97}\, (RM - RB)_{t-1}$$

$$+ \underset{(2.43)}{.032} \left(\frac{CMHC}{PH}\right) + \underset{(3.38)}{.041} \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 3.92 $\quad$ ρ = .312 $\quad$ D/W = 1.96

B-3 Price of houses, 1Q57-4Q67

$$PH = \underset{(4.16)}{121.7} + \underset{(2.12)}{1.9}\, Q1 + \underset{(5.22)}{4.6}\, Q2 + \underset{(3.03)}{2.6}\, Q3 + \underset{(5.20)}{77.72}\, (YDP/HH)_{t-1}$$

$$- \underset{(7.89)}{274.23}\, (STH/HH) + \underset{(7.76)}{1.44}\, PGNE_{t-1}$$

SEE = 2.02 $\quad$ R^2 = .98 $\quad$ D/W = 1.11

B-3'

$$PH = \underset{(2.99)}{118.9} + \underset{(2.29)}{1.4}\, Q1 + \underset{(5.91)}{4.2}\, Q2 + \underset{(4.16)}{2.5}\, Q3 + \underset{(5.03)}{91.36}\, (YDP/HH)_{t-1}$$

$$- \underset{(5.24)}{254.18}\, (STH/HH) + \underset{(5.24)}{1.32}\, PGNE_{t-1}$$

SEE = 1.73 $\quad$ ρ = .450 $\quad$ D/W = 1.62

B-4 Total stock of housing units, 2Q54-4Q67

$$STH^{*} = \underset{(776.94)}{1.000}\ STH_{t-1} + \underset{(3.01)}{.213}\ HST + \underset{(5.19)}{.339}\ HST_{t-1} + \underset{(4.74)}{.248}\ HST_{t-2} + \underset{(4.46)}{.086}\ HST_{t-3}$$

SEE = 6.44 $\qquad$ $R^2 = .999$ $\qquad$ D/W = 2.03

B-4'

$$STH^{*} = \underset{(784.50)}{1.000}\ STH_{t-1} + \underset{(3.01)}{.212}\ HST + \underset{(5.23)}{.339}\ HST_{t-1} + \underset{(4.77)}{.248}\ HST_{t-2} + \underset{(4.49)}{.086}\ HST_{t-3}$$

SEE = 6.44 $\qquad$ $\rho = -.015$ $\qquad$ D/W = 2.00

B-5 Construction costs (including land costs), 3Q55-4Q67

$$\ln CLC - \ln CLC_{t-4} = \underset{(1.20)}{-.006} + \underset{(1.67)}{.037}\ (\ln INRC - \ln \widehat{INRC})_{t-1}$$

* These equations were estimated using second (Z_2) and third (Z_3) degree Almon variables created on housing starts. The actual regressions are:

$$STH = \underset{(776.94)}{1.000}\ STH_{t-1} + \underset{(4.30)}{3.33}\ Z_2 - \underset{(3.73)}{2.44}\ Z_3$$

$R^2 = .99$ $\qquad$ D/W = 2.03

$$STH = \underset{(784.50)}{1.000}\ STH_{t-1} + \underset{(4.32)}{3.33}\ Z_2 - \underset{(3.75)}{2.44}\ Z_3$$

$\rho = -.015$

$$+ \underset{(2.73)}{.070} (\ln IRC - \ln \hat{IRC})_{t-1}$$

$$+ \underset{(5.24)}{.36} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(1.59)}{.07} (\ln L - \ln L_{t-4})$$

$$+ \underset{(2.07)}{.020} (\ln R03 - \ln R03_{t-4}) + \underset{(2.72)}{.017} DVST$$

SEE = .017 R^2 = .73 D/W = 1.16

B-5'

$$\ln CLC - \ln CLC_{t-4} = \underset{(.49)}{-.004} + \underset{(.53)}{.015} (\ln INRC - \ln \hat{INRC})_{t-1}$$

$$+ \underset{(.92)}{.024} (\ln IRC - \ln \hat{IRC})_{t-1}$$

$$+ \underset{(3.55)}{.33} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(1.82)}{.10} (\ln L - \ln L_{t-4})$$

$$+ \underset{(1.92)}{.021} (\ln R03 - \ln R03_{t-4}) + \underset{(1.52)}{.014} DVST$$

SEE = .015 ρ = .606 D/W = 1.89

B-6 Land costs, 2Q54-4Q67

$$L = \underset{(4.16)}{-84.1} + \underset{(4.38)}{.022} POPT + \underset{(4.93)}{.028} YDP - \underset{(3.29)}{.081} STH + \underset{(5.43)}{.65} \Delta L$$

SEE = 4.70 R^2 = .96 D/W = .98

B-6'

$$L = \underset{(1.43)}{-42.0} + \underset{(1.74)}{.009}\ POPT + \underset{(2.93)}{.020}\ YDP - \underset{(1.06)}{.026}\ STH + \underset{(6.21)}{.45}\ \Delta L$$

SEE = 3.92 ρ = .441 D/W = 1.31

B-7 Conventional mortgage rate, 2Q54-4Q67

$$RC = \underset{(6.07)}{12.9} - \underset{(6.70)}{13.07}\ (STH/HH)_{t-1} + \underset{(3.83)}{3.82}\ (YDP/HH) - \underset{(5.49)}{.0027}\ ALTM$$

$$+ \underset{(6.00)}{.0041}\ MLTM_{t-1} + \underset{(6.22)}{.45}\ RNHA + \underset{(4.00)}{.28}\ RB_{t-1}$$

SEE = .100 R^2 = .97 D/W = 1.26

B-7'

$$RC = \underset{(4.89)}{13.6} - \underset{(5.47)}{14.49}\ (STH/HH)_{t-1} + \underset{(3.94)}{4.50}\ (YDP/HH) - \underset{(3.27)}{.0020}\ ALTM$$

$$+ \underset{(3.35)}{.0029}\ MLTM_{t-1} + \underset{(5.26)}{.38}\ RNHA + \underset{(3.86)}{.29}\ RB_{t-1}$$

SEE = .088 ρ = .486 D/W = 2.05

B. The Extended Housing Model

B-8 Investment in residential construction, 1Q54-4Q67

$$IRC = \underset{(2.42)}{45.02} + \underset{(14.55)}{6.56}\ HSS + \underset{(6.84)}{3.00}\ HSS_{t-1} + \underset{(4.34)}{2.00}\ HSS_{t-2}$$

$$+ \underset{(4.69)}{2.89}\ HSM + \underset{(1.59)}{1.19}\ HSM_{t-1} + \underset{(1.78)}{1.15}\ HSM_{t-2} + \underset{(3.18)}{1.64}\ HSM_{t-3}$$

SEE = 16.46 R^2 = .94 D/W = 1.44

B-8'

$$IRC = \underset{(1.52)}{32.93} + \underset{(14.95)}{6.77}\ HSS + \underset{(7.64)}{3.06}\ HSS_{t-1} + \underset{(4.89)}{2.18}\ HSS_{t-2}$$

$$+ \underset{(5.17)}{2.96}\ HSM + \underset{(2.03)}{1.29}\ HSM_{t-1} + \underset{(1.92)}{1.10}\ HSM_{t-2} + \underset{(3.17)}{1.70}\ HSM_{t-3}$$

SEE = 15.74 $\quad$ $\rho = .294$ $\quad$ D/W = 1.97

B-9 Single housing starts, 1Q57-4Q67

$$HSS = \underset{(1.14)}{21.4} - \underset{(8.50)}{12.6}\ Q1 + \underset{(3.24)}{5.3}\ Q2 + \underset{(2.95)}{4.2}\ Q3 + \underset{(2.19)}{5.20}\ WW$$

$$+ \underset{(.56)}{13.02}\ (PH/CC)_{t-1} - \underset{(1.55)}{.11}\ L - \underset{(1.07)}{1.98}\ RM_{t-1}$$

$$+ \underset{(2.87)}{5.63}\ (RM - RB)_{t-1} + \underset{(1.95)}{.022}\ \left(\frac{CMHCS}{PH}\right) + \underset{(4.42)}{.051}\ \left(\frac{CMHCS}{PH}\right)_{t-1}$$

SEE = 2.91 $\quad$ $R^2 = .89$ $\quad$ D/W = 2.05

B-10 Multiple housing starts, 1Q57-4Q67

$$HSM = \underset{(.19)}{-1.9} - \underset{(6.15)}{7.3}\ Q1 + \underset{(2.08)}{2.7}\ Q2 + \underset{(2.57)}{3.0}\ Q3 + \underset{(1.49)}{3.22}\ WW$$

$$+ \underset{(3.63)}{34.94}\ (R/CC)_{t-1} + \underset{(1.20)}{.07}\ L - \underset{(3.56)}{4.97}\ RM_{t-1} + \underset{(.10)}{.17}\ (RM - RB)_{t-1}$$

$$+ \underset{(2.60)}{.114}\ \left(\frac{CMHCM}{PH}\right) + \underset{(1.63)}{.062}\ \left(\frac{CMHCM}{PH}\right)_{t-1}$$

SEE = 2.75 $\quad$ $R^2 = .86$ $\quad$ D/W = 1.55

B-10'

$$HSM = \underset{(.44)}{-5.6} - \underset{(7.48)}{7.4}\ Q1 + \underset{(1.61)}{2.0}\ Q2 + \underset{(2.64)}{2.6}\ Q3 + \underset{(1.63)}{3.10}\ WW$$

$$+ \underset{(2.58)}{29.97}\ (R/CC)_{t-1} + \underset{(1.55)}{.10}\ L - \underset{(2.28)}{4.10}\ RM_{t-1} + \underset{(.35)}{.70}\ (RM - RB)_{t-1}$$

$$+ \underset{(1.80)}{.074}\ \left(\frac{CMHCM}{PH}\right) + \underset{(1.09)}{.040}\ \left(\frac{CMHCM}{PH}\right)_{t-1}$$

SEE = 2.67 ρ = .331 D/W = 1.91

B-11 Price of houses, 1Q57-4Q67

$$PH = \underset{(3.82)}{178.5} + \underset{(1.55)}{1.3}\ Q1 + \underset{(4.41)}{3.9}\ Q2 + \underset{(2.49)}{2.0}\ Q3 + \underset{(2.07)}{34.44}\ (YDP/HH)_{t-1}$$

$$- \underset{(7.93)}{392.58}\ (STHO/HH) + \underset{(3.33)}{1.29}\ PGNE_{t-1} + \underset{(1.21)}{.29}\ R_{t-1} - \underset{(.50)}{1.01}\ RM_{t-1}$$

SEE = 1.89 R^2 = .98 D/W = 1.11

B-11'

$$PH = \underset{(3.41)}{174.9} + \underset{(1.36)}{.8}\ Q1 + \underset{(4.67)}{3.3}\ Q2 + \underset{(3.43)}{2.0}\ Q3 + \underset{(2.42)}{50.19}\ (YDP/HH)_{t-1}$$

$$- \underset{(5.69)}{365.47}\ (STHO/HH) + \underset{(2.20)}{.73}\ PGNE_{t-1} + \underset{(1.39)}{.35}\ R_{t-1} + \underset{(.46)}{1.10}\ RM^{\dagger}_{t-1}$$

SEE = 1.60 ρ = .450 D/W = 1.53

(† This variable has the wrong sign and is insignificant)

B-12 Rent, 1Q57-4Q67

$$R = \underset{(.63)}{-17.7} + \underset{(4.92)}{303.14}\ (YDP/POPT)_{t-1} - \underset{(3.34)}{1636.10}\ (SHR/POPT)_{t-1}$$

$$+ \underset{(4.67)}{1.17}\ PGNE_{t-1} + \underset{(1.88)}{.26}\ PH_{t-1} + \underset{(1.84)}{2.11}\ RM_{t-1}$$

SEE = 1.39 R^2 = .99 D/W = 1.26

B-12'

$$R = \underset{(.03)}{.82} + \underset{(4.92)}{335.48}\ (YDP/POPT)_{t-1} - \underset{(3.20)}{1707.80}\ (SHR/POPT)_{t-1}$$

$$+ \underset{(3.46)}{.82}\ PGNE_{t-1} + \underset{(3.05)}{.39}\ PH_{t-1} + \underset{(1.44)}{2.02}\ RM_{t-1}$$

SEE = 1.25 ρ = .380 D/W = 1.51

B-13 Stock of owner-occupied housing units, 2Q54-4Q67

$$SHO^* = \underset{(1172.57)}{.9989}\ SHO_{t-1} + \underset{(4.63)}{.281}\ HSS + \underset{(8.27)}{.400}\ HSS_{t-1} + \underset{(6.88)}{.285}\ HSS_{t-2}$$

$$+ \underset{(6.21)}{.098}\ HSS_{t-3}$$

SEE = 4.16 R^2 = .999 D/W = 2.23

* These equations were estimated using second (Z_2) and third (Z_3) degree Almon variables created on single unit housing starts. The actual regressions are:

$$SHO = \underset{(1172.57)}{.9989}\ SHO_{t-1} + \underset{(5.85)}{3.75}\ Z_2 - \underset{(4.75)}{2.69}\ Z_3$$

R^2 = .99 D/W = 2.23

$$SHO = \underset{(1297.99)}{.9989}\ SHO_{t-1} + \underset{(6.18)}{3.77}\ Z_2 - \underset{(4.95)}{2.71}\ Z_3$$

ρ = -.123

B-13'

$$SHO^{*} = \underset{(1297.99)}{.9989}\ SHO_{t-1} + \underset{(4.77)}{.280}\ HSS + \underset{(9.11)}{.401}\ HSS_{t-1} + \underset{(7.38)}{.287}\ HSS_{t-2}$$

$$+ \underset{(6.59)}{.099}\ HSS_{t-3}$$

SEE = 4.13 $\rho = -.123$ D/W = 2.05

B-14 Stock of renter-occupied housing units, 2Q54-4Q67

$$SHR^{**} = \underset{(809.86)}{.9998}\ SHR_{t-1} + \underset{(1.18)}{.090}\ HSM + \underset{(7.18)}{.277}\ HSM_{t-1} + \underset{(5.82)}{.279}\ HSM_{t-2}$$

$$+ \underset{(5.10)}{.179}\ HSM_{t-3} + \underset{(4.75)}{.058}\ HSM_{t-4}$$

SEE = 3.14 $R^2 = .999$ D/W = 1.38

*See footnote on the previous page.

** These equations were estimated using second (Z_2) and third (Z_3) degree Almon variables created on multiple dwelling unit housing starts. The actual regressions are:

$$SHR = \underset{(809.86)}{.9998}\ SHR_{t-1} + \underset{(4.54)}{3.97}\ Z_2 - \underset{(3.80)}{3.09}\ Z_3$$

$R^2 = .99$ D/W = 1.38

$$SHR = \underset{(587.45)}{.9997}\ SHR_{t-1} + \underset{(3.66)}{3.42}\ Z_2 - \underset{(3.05)}{2.52}\ Z_3$$

$\rho = .350$

B-14'

$$SHR^{**} = \underset{(587.45)}{.9997}\, SHR_{t-1} + \underset{(2.08)}{.154}\, HSM + \underset{(5.29)}{.277}\, HSM_{t-1} + \underset{(4.53)}{.257}\, HSM_{t-2}$$

$$+ \underset{(4.07)}{.159}\, HSM_{t-3} + \underset{(3.82)}{.051}\, HSM_{t-4}$$

SEE = 2.96 ρ = .350 D/W = 2.02

B-15 Construction costs, 3Q55-4Q67

$$\ln CC - \ln CC_{t-4} = \underset{(2.13)}{-.0090} + \underset{(.76)}{.015}\, (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(4.22)}{.104}\, (\ln IRC - \ln \widehat{IRC})_{t-1}$$

$$+ \underset{(6.36)}{.425}\, (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(1.39)}{.013}\, (\ln R03 - \ln R03_{t-4}) + \underset{(3.38)}{.021}\, DVST$$

SEE = .016 R^2 = .76 D/W = .83

**See footnote on the previous page.

B-15'

$$\ln CC - \ln CC_{t-4} = \underset{(.53)}{.0096} - \underset{(.55)}{.013} (\ln INRC - \ln \widehat{INRC})^{\dagger}_{t-1}$$

$$+ \underset{(2.09)}{.041} (\ln IRC - \ln \widehat{IRC})_{t-1}$$

$$+ \underset{(2.86)}{.235} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(1.98)}{.017} (\ln R03 - \ln R03_{t-4}) + \underset{(2.29)}{.021} DVST$$

SEE = .012 ρ = .900 D/W = 2.02

(† This variable has the wrong sign and is insignificant)

LIST OF VARIABLES AND SOURCES

AL	Total assets of twelve life insurance companies. Millions. Bank of Canada: *Statistical Summary*, year-end values interpolated by net investment transactions.
ALTM	Total assets (weighted) of trust and mortgage companies plus total assets less policy loans of twelve life insurance companies. Millions. (11240)
AM	Total assets of mortgage loan companies. Millions. (1112)
AT	Total assets of trust companies. Millions. (1100)
CC	Index of average construction costs per square foot on new single detached NHA dwellings. 1957=100. Central Mortgage and Housing Corporation: *Canadian Housing Statistics, 1966*, Table 94.
CLC	Index of average cost of construction per square foot (including land) of new single detached NHA dwellings. 1957=100. (Constructed from 11369)
CMHC	Central Mortgage and Housing Corporation direct mortgage approvals. Millions. (11440)
CMHCM	Central Mortgage and Housing Corporation direct mortgage approvals for multiple dwellings. Millions. (11371)
CMHCS	Central Mortgage and Housing Corporation direct mortgage approvals for single dwellings. Millions. (11370)
DVST	Dummy variable for sales tax on building materials; equals 1 from third quarter 1963 to the end of 1965, zero elsewhere. (11027)
HH	Number of families in Canada. Thousands. (3054)

HSM Multiple housing starts. Thousands. (3064 - 3068)

HSS Single housing starts. Thousands. (3068)

HST Total housing starts. Thousands. (3064)

INRC Investment in non-residential construction. Millions of 1957 dollars. (11307)

IRC Investment in new residential construction. Millions of 1957 dollars. (145)

L Index of land costs on new single detached NHA dwellings. 1957=100. (11372)

MAB Mortgage approvals of chartered banks. Millions. (622)

MAL Mortgage approvals of all life insurance companies. Millions. (626)

MAM Mortgage approvals of mortgage loan companies. Millions. Supplied by Central Mortgage and Housing Corporation.

MAT Mortgage approvals of trust companies. Millions. Supplied by Central Mortgage and Housing Corporation.

MB Mortgage holdings of chartered banks. Millions. Bank of Canada: *Statistical Summary*.

ML Mortgage holdings of twelve life insurance companies. Millions. (1138)

MLTM Weighted sum of total mortgage holdings of trust, mortgage and twelve life insurance companies. Millions. (11645)

MM Mortgage holdings of mortgage loan companies. Millions. (1104)

MT Non-interest rate attributes of mortgages.

MT' Mortgage holdings of trust companies. Millions. (1097)

PGNE — Deflator of gross national expenditure, less government expenditure and less farm inventories. 1957=100. (Adjusted from 9153)

PH — Index of housing prices. 1957=100. (11070)

PL — Policy loans of twelve life insurance companies. Millions. (1137)

PMLS — Housing price index of Multiple Listing Service sales. 1957=100. A four-quarter moving average centered on the third quarter of the average monthly value of real estate sales. The Canadian Association of Real Estate Boards: *The Canadian Realtor*.

PNHA — Index of the cost of new single detached NHA dwellings. 1957=100. Central Mortgage and Housing Corporation: *Canadian Housing Statistics 1966*, Table 94.

POPT — Total Canadian population. Millions of persons. (3032)

Q1 — First-quarter seasonal dummy. 1 in first quarter, zero elsewhere. (11073)

Q2 — Second-quarter seasonal dummy. 1 in second quarter, zero elsewhere. (11074)

Q3 — Third-quarter seasonal dummy. 1 in third quarter, zero elsewhere. (11075)

R03 — Average yield on short-term Government of Canada bonds, zero to three years. (1365)

R1GIC — Interest rate paid on trust and mortgage loan company one-year term liabilities. (2779)

R5GIC — Interest rate paid on trust and mortgage loan company five-year term liabilities. (2780)

R40 — McLeod, Young, Weir average yield on forty industrial bonds. (1162)

R90	Interest rate paid by chartered banks on 90-day deposit receipts. (1164)
R	Index of average monthly rents. 1957=100. (11368)
RB	Average bond interest yield. Weighted average of ten industrial, ten public utility, ten municipal, ten provincial bond rates; and the average yield on long-term Government of Canada bonds, ten or more years to maturity.
RC	Conventional mortgage rate. (1096)
RCH	Interest rate paid on trust and mortgage loan company chequable deposits. (1127)
RDL	Chartered banks' day-loan rate. (2781)
RLC	Average yield on long-term Government of Canada bonds, ten or more years to maturity. (2764)
RM	Average mortgage rate. (11318)
RNHA	Average of actual month-end NHA rates: maximum NHA rates (245) adjusted in second quarter of 1954 to fourth quarter of 1954 according to [37], pp. 159-160.
RPS	Interest rate paid on chartered banks' personal savings deposits. (2778)
SHO	Stock of owner-occupied housing units. Thousands. (11366)
SHR	Stock of renter-occupied housing units. Thousands. (11367)
STH	Total stock of housing units. Thousands. (3057)
T	Time trend, equals 1 in first quarter of 1952.
TBA	Total major assets of chartered banks. Millions. (383)

W — A wealth variable represented by an eight-quarter distributed (Almon) lag on current-dollar gross national expenditure.

WC — Index of average hourly earnings of hourly-rated construction workers. 1957=100. (Constructed from 2486)

WW — Dummy winter works variable; equals 1 in fourth quarters of 1963, 1964 and 1965, zero elsewhere. (11320)

YDP — Permanent real disposable income. Millions of 1957 dollars. (3052)

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No. 7

BANK OF CANADA
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THE STRUCTURE OF RDX2

PART 1

1971

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PREFACE

RDX2 is a large aggregate econometric model of the Canadian economy. It is a product of the continuing programme of econometric research sponsored by the Research Department of the Bank of Canada. Since the publication of RDX1 in 1969, many numbers have flowed through our hands. The structure of the economy has been shifting and major revisions of the national accounts [10] have forced us to form new views of the recent economic history of Canada. In addition to these changes, our expectations have increased concerning the variety of questions that the RDX series of models should be able to face, as we have sought to apply the many lessons learned from RDX1. For instance, our interest in the international repercussions of national economic policies has led us to develop detailed explanations of trade and capital flows and associated portfolio changes; the monetary sector of RDX2 is more fully developed; and the links between the monetary and real economies more fully articulated. The net effect of all these forces is that RDX2 is much larger and more interrelated than RDX1. The links between the sectors of RDX2, and the links between RDX2 and variables generated in other countries, are more extensive than those of any other national econometric model of which we are aware. RDX2 will be subject to alteration as we continue with our simulations and add to the data sample, but, as a whole, RDX2 is much less 'preliminary' than RDX1. We used RDX1 as a learning device to a great extent. Long before our experiments with that model were complete we had developed many equations preferable to those in

the RDX1 structure. The extensive revisions of the national accounts ensured the obsolescence of RDX1, which is based on unrevised national accounts data. Subsequently we have devoted our efforts entirely to RDX2 rather than attempting to use the revised data to rebuild RDX1.

We continue to be fortunate in having an everchanging cohort of able and enthusiastic collaborators. Some of them have made contributions too large and too specific to be properly acknowledged by a mere listing of names. Al Coombs has been our principal systems engineer and has devoted many dedicated hours and much ingenuity to the improvement of our estimation and simulation programmes. The primary data are the responsibility of Marg Fitzpatrick and a revolving group of assistants, using balance of payments data developed by Roy Flett and Doug Smee, and so on. Jim Dingle, during the course of a year devoted to the project, was a notable jack-of-all-sectors and in particular was responsible for a good deal of early development of our measures of wealth. Tom Maxwell has done much of the estimation and simulation of the model of the foreign exchange market, and Jillian Broadbent has been a valuable contributor of equations for long-term capital movements and related current account items. Tom Brady has done the bulk of the estimation work in the financial sector. We were fortunate to have Lynne Duncan, Terry Ford, and Paul Masson as enthusiastic helpers during the summers of 1970 and 1971. Other people who have provided important help or advice that has influenced RDX2 include Alan Adamson, John Fountain, Guy Glorieux, Sandy Schellenberg, Danielle Tuchmaier, Mike Walker, and Edith Whyte. The study has been efficiently typed, under some pressure of time, by Judy Crew, working on a

typewriter terminal linked to tape storage and high-speed printers. Effective use of this system has led us to abandon footnotes and to keep text and equations separate. Margaret Bailey, as editor, has prepared the manuscript for the printer and supervised its publication. Not only has she saved us from many follies of fact and prose but she has done this and performed a myriad of other chores with astonishing patience and continuous good humour.

We are grateful, of course, for the continued advice and support of the rest of the Research Department.

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RESUME

La publication du présent ouvrage - The Structure of RDX2 - constitue le dernier stade de la mise au point, au Département des recherches de la Banque du Canada, d'un nouveau modèle économétrique trimestriel de l'économie canadienne. Le modèle RDX2 est un instrument de travail beaucoup plus élaboré et plus souple que le RDX1, qui l'a précédé; le nombre de fonctions estimatives de comportement qu'il englobe est presque trois fois plus élevé que celui du premier modèle et la structure fondamentale de presque tous les secteurs est différente. Comme dans le cas du RDX1, le RDX2 vise à constituer un instrument susceptible de simuler de façon réaliste, à court et moyen terme, l'éventail des politiques économiques que le gouvernement canadien pourrait adopter dans diverses situations. C'est pourquoi une attention particulière a été accordée à l'élaboration des secteurs gouvernemental et monétaire du modèle et à leur intégration dans l'ensemble de l'économie. En outre, le RDX2 diffère très nettement du RDX1 par le traitement beaucoup plus détaillé qu'il réserve aux équations relatives au commerce extérieur du Canada et aux mouvements de capitaux entre le Canada et l'étranger. Cette importance accrue accordée au secteur international dans le nouveau modèle s'explique par la nécessité de représenter d'une façon plus précise l'incidence internationale des politiques économiques et de l'évolution conjoncturelle à l'étranger et au Canada et, accessoirement, par le désir d'établir une relation entre le RDX2 et le modèle très élaboré de l'économie américaine qu'est le MPS.

La diversité des objectifs du RDX2 a conduit à la définition d'un certain nombre de concepts théoriques. Ainsi, le concept du prix auquel les capitaux sont susceptibles d'être offerts est le fruit de nos évaluations de la valeur marchande courante des composantes de la valeur nette du patrimoine national, qui comprennent les immobilisations des entreprises, la dette publique, les logements et les biens de consommation. On obtient également une évaluation du taux anticipé de l'augmentation des prix à la consommation à partir du prix de l'offre des capitaux, évalué en termes réels et en termes nominaux. Ce prix influence les dépenses d'investissement, les flux internationaux de capitaux et le comportement de l'épargne. Par contre, le taux anticipé de l'inflation influe sur l'évolution des taux des salaires, sur la construction résidentielle et sur les décisions en matière de politique économique des pouvoirs publics.

L'interdépendance des demandes portant sur les facteurs de production - bâtiments, machines, équipement et main-d'oeuvre - se fait sentir dans tout le modèle RDX2. Les demandes relatives à ces facteurs interdépendants ont été intégrées dans une fonction synthétique de la production, de sorte que leur compatibilité et celle de leur processus d'ajustement se trouvent assurées. Ce schéma suppose que les entreprises cherchent à minimiser leurs coûts et se traduit par une amélioration sensible des équations relatives à la constitution des stocks, à l'emploi, aux heures de travail et aux dépenses en immobilisations. La fonction synthétique de la production permet de définir de nouvelles méthodes d'évaluer l'offre globale, la demande, le degré d'utilisation de la capacité de production et les variations à court terme de la productivité. Ces évaluations, en retour, jouent un rôle important dans les équations relatives aux

prix et au commerce extérieur. Un modèle portant sur la demande pour les divers facteurs de production permet en outre de mesurer les tendances de la productivité de la main-d'oeuvre - qui constitue un élément déterminant du niveau des salaires réels dans les entreprises.

Le RDX2 cherche, beaucoup plus que ne le font la plupart des autres modèles, à déterminer l'évolution des dépenses et de la composition des portefeuilles en fonction des taux de croissance du revenu et du patrimoine national. Ainsi, dans le RDX2, les flux internationaux de capitaux sont, pour la plupart, liés directement à l'évolution des portefeuilles canadiens et étrangers ainsi qu'à la composition de ces portefeuilles et aux taux de rendement. Parallèlement, la demande du secteur non financier pour diverses catégories d'avoirs liquides est déterminée à l'aide d'un modèle qui a trait au comportement des portefeuilles et tient compte de la contrainte imposée par la croissance du portefeuille global de ces avoirs. Dans le cas du gouvernement fédéral, des provinces et des municipalités, il a été tenu compte de tous les mouvements de fonds, de sorte que les relations assurant l'équilibre entre flux et stocks ont dû être spécifiées.

Le modèle comporte vingt-et-un secteurs. Pour les besoins de la simulation, il est aisé d'en exclure soit un ou plusieurs secteurs, soit une ou plusieurs équations. Les chapitres 2 à 11, dans la première partie de l'étude, présentent une analyse, secteur par secteur, des équations du modèle. Ces dix chapitres portent sur les sujets suivants: la consommation et la construction de logements; les investissements et la production des entreprises; le commerce extérieur; l'emploi et les heures de travail dans les entreprises, la population active et la

démographie; la répartition des revenus: les salaires, les bénéfices et les dividendes; la formation des prix; les opérations des gouvernements; le secteur financier; la balance des capitaux à long terme; les cours du change, les réserves officielles et les mouvements des capitaux à court terme.

La seconde partie de l'étude, publiée séparément, présente les équations qui constituent actuellement le modèle RDX2 - classées d'abord par secteurs puis, à l'intérieur de chaque secteur, selon leur numéro d'ordre.

Comme dans le cas du RDX1, The Structure of RDX2 sera suivie d'une analyse approfondie de la dynamique du RDX2 - analyse dont les résultats seront publiés ultérieurement. On trouvera au Chapitre 12 une introduction à la dynamique du RDX2. On y expose notamment la fidélité avec laquelle le modèle parvient à suivre l'évolution de l'économie canadienne, non seulement au cours de la période qui a fourni les données de base mais également par la suite, ainsi que ses réactions au test que représente l'introduction de tout un éventail de politiques économiques possibles.

PRECIS

The publication of The Structure of RDX2 marks completion within the Research Department of the Bank of Canada of a new quarterly model of the Canadian economy. RDX2 is a much larger and more flexible tool than its predecessor, RDX1. There are almost three times as many estimated behavioural relationships in RDX2 as in RDX1, and the underlying structure of almost every sector is different. As with RDX1, RDX2 is intended to be a vehicle for realistic short- and medium-term simulation of alternative policy choices open to government; hence particular attention has been paid to the elaboration of the government and monetary sectors of the model and to their integration with the total economy. In addition, RDX2 differs most markedly from RDX1 in the expanded treatment given to Canada's international trade and capital flow relationships. This expanded treatment of the international sector of the model arises from a desire to represent more adequately the international repercussions of foreign and domestic events and policies, and, derivative from this, our undertaking to link RDX2 with the large scale MPS model of the U.S. economy.

The variety of objectives for RDX2 has led to a number of theoretical developments. The concept of the supply price of capital is an outgrowth of our measurement of current market values for components of domestic net worth, which includes business capital stock, government debt, dwellings, and consumer durables. A measure of the expected rate of increase of consumer prices derives from measures of the supply price of capital in both real and nominal terms. The supply price of capital

influences investment expenditure, international capital movements, and savings behaviour. The expected rate of inflation influences wage rate movements, residential construction and public policy decisions.

A model of interrelated demands for buildings, machinery and equipment, and labour services has ramifications throughout RDX2. A synthetic production function underlies the related factor demands in such a way that consistency of factor demands and adjustment is assured. This scheme, which assumes cost-minimizing behaviour, gives rise to much-improved equations for inventory demand, employment and hours, and capital expenditure. Our synthetic production function allows us to develop new measures for aggregate supply, demand, capacity utilization, and short-term changes in productivity. These measures in turn play important roles in our equations for prices and foreign trade. The factor-demand model also gives rise to a trend measure of labour efficiency that is the main determinent of the level of the business real wage.

In RDX2 a good deal more attention is given than in other models to specifying expenditure and portfolio allocation behaviour under varying rates of growth of income and wealth. For example, in RDX2 most international capital flows are tied directly to growth in domestic and foreign portfolios as well as to existing portfolio proportions and rates of return. Correspondingly, the demands of the nonfinancial sector for various liquid assets are determined (through constrained estimation of portfolio behaviour) by the growth of the total portfolio of such assets. Flow-of-funds accounting is made complete for federal as well as provincial and municipal

governments so that here too we specify the necessary connections between stock and flow equilibrium.

The model is comprised of twenty-one sectors. For purposes of simulation, one or more sectors or any single equation or group of equations may be easily exogenized. Chapters 2 to 11, appearing in Part 1 of the study, contain a sector-by-sector discussion of the equations of the model. The ten chapters in Part 1 of the study dealing with the equations are entitled: Consumption and Residential Construction; Business Investment and Output; Foreign Trade; Business Employment and Hours, Labour Force, and Population; Income Distribution: Wages, Profits and Dividends; Price Formation; The Operations of Governments; The Financial Sector; The Long-Term Capital Account; and Foreign Exchange Rates, Official Reserves, and Short-Term Capital Flows.

Part 2 of the study (a separate volume) contains the equations currently in the RDX2 model arranged by sector and numbered within each sector.

As with RDX1, The Structure of RDX2 will be followed by an extensive examination of the dynamics of RDX2, which will be published in a subsequent study. Chapter 12 of the present study contains an introduction to the dynamics of RDX2 through a recording of the intra- and post-sample tracking qualities of the model and its response to a representative sample of policy shocks.

CHAPTER 1

AN INTRODUCTORY SURVEY OF THE MODEL

A Introduction

RDX2 is our contribution to the latest generation of aggregate econometric models. Like the higher generation computers that have made its estimation and simulation feasible, RDX2 is a much larger and more flexible tool than its predecessor, RDX1. The users of RDX1 will find little that is familiar in RDX2. There are almost three times as many estimated behavioural equations in RDX2 as in RDX1, and the underlying structure is different in almost every sector. We have tried to make good use of the lessons learned from our first model, and the structure of RDX2 reflects everywhere our attempts to improve upon RDX1.

Although we have devised a highly interdependent model, which will be fully comprehensible to us only after many months of simulation, we are hopeful that its basic structure will remain fairly stable for some time. Therefore we are taking the earliest opportunity to distribute our equations and data so that other researchers can share in the process of learning about and consequently improving RDX2. This version of the model is preliminary in the sense that we expect to improve on some of the specifications during the course of the simulation experiments we plan to undertake. After testing and a full range of experiments, we shall publish the results along with the revised

equation structure and parameter estimates. The main change in the parameter estimates will probably arise from the use of the structurally ordered instrumental variables estimation technique (SOIV, described in [19] and [44]) in place of ordinary least squares (OLS). As with RDX1, we ensure consistency by using instrumental variables regression in the second stage of the procedure. Our experience with applying both methods of estimation to RDX1 suggests that the equation structure and main single-stage parameter estimates are not likely to be altered much by the simultaneous equation estimation.

In this chapter we outline the research strategy underlying RDX2 and preview the more comprehensive description of its structure to be found in Chapters 2 to 11. We shall defer until Chapter 12 a discussion of the main chains of causal influence to be found in the model. Even that discussion will be fairly sketchy, since we would prefer to present a complete analysis after we have had more experience with using RDX2. Appendix A, an alphabetical list of the variables used in the model, and Appendix B, the equations of the model divided into twenty-one sectors, appear in Part 2 of the study. The explanation of RDX2 is in this volume - Part 1 of the study.

We state in section B of this chapter what we wish to do with RDX2, and outline some of its unifying features. In section C we make a preliminary survey, under five headings, of the main aspects of each sector of the model.

B Sources and Uses of RDX2

RDX2 is intended to be a vehicle for realistic short- and medium-term simulations of alternative policy choices. This primary objective as well as other anticipated demands on the model shaped our approach to its construction and has led to a number of theoretical developments.

We have completed the modelling of government activities (begun in [28]) so as to clarify the roles of governments and include all important policy instruments in a fairly accurate way.

Our continuing interest in monetary policy encouraged us to make use of recent developments in monetary and expenditure theory to forge a variety of links between goods markets and financial markets.

Our undertaking to link RDX2 with a large model of the U.S. economy (a project outlined in [36]) strengthened our already substantial resolve to explain international flows of goods, capital, and people well enough to picture the full international repercussions of domestic events and policies.

Inflationary experience in the late 1960s affected the development of RDX2 in two ways. First, we became anxious to explain wage and price movements in more structural detail. Second, because of the shifting gap between nominal and real rates of interest we were forced to be much more precise than we and other researchers have been in modelling the influence of price expectations on behaviour.

The variety of objectives for RDX2 has led to a number of theoretical developments. As a consequence, no grand centerpiece emerges, although there are a number of features pervasive enough to merit advance billing and others that will be demonstrated as the various sectors are described.

1 The supply price of capital

Our concept of the supply price of capital (RHO) is an outgrowth of our measurement of current market values for components of domestic net worth, which includes business capital stock, government debt, dwellings, and consumer durables. We have been able to estimate the supply price of capital in both real and nominal terms, and consequently to derive a measure of the expected rate of increase in consumer prices. The supply price of capital influences capital expenditure, international capital movements, and savings behaviour. Expectations about a variety of factor costs determine the degree of factor substitution in the factor-demand model described below.

2 Investment and output

Our model of the interrelated demands for buildings, machinery and equipment, and labour services has ramifications throughout RDX2. A synthetic production function underlies the related factor demands in such a way that consistency of factor demands and adjustment is assured. This scheme, which assumes cost-minimizing behaviour, gives rise to greatly improved

equations for inventory demand, employment and hours, and capital expenditure. In addition, it allows us to develop new measures for aggregate supply, demand, capacity utilization, and short-term changes in productivity. These measures in turn are important in our equations for prices and foreign trade. The factor-demand model also gives rise to a trend measure of labour efficiency, which is the main determinant of the level of the business real wage.

3 Stock and flow equilibrium

We go further than other model-builders in specifying expenditure and portfolio allocation behaviour that makes sense under varying rates of growth of income and wealth. For example, most of our international capital flow equations are tied directly to growth in domestic and foreign portfolios as well as to existing portfolio proportions and rates of return. Correspondingly, the demands of the nonfinancial sector for various liquid assets are determined, through constrained estimation of portfolio behaviour, by the growth of the total portfolio of such assets. Flow-of-funds accounting is made complete for federal as well as provincial and municipal governments so that here too we specify the necessary connections between stock and flow equilibrium. Our zeal also led us to specify our main price and wage equations so that prices and wages have reasonable equilibrium levels as well as rates of change. We do not emphasize portfolio and other stock or level equilibrium properties at the expense of reasonable

disequilibrium properties, because we have developed a range of disequilibrium adjustment mechanisms. We have also concentrated much effort on specifying expectations mechanisms and the time paths for adjustment. Features of the new adjustment processes include a ratio of aggregate demand and supply imbalance derived from the new supply and demand concepts we describe in Chapter 3, and a measure of credit availability based on the ratio of chartered bank earning liquid assets to total assets (RABEL). The difference between RABEL and its target value (RABELD) has important effects on bank loans, international capital movements, and domestic expenditure.

RDX2 is characterized by other novel features, but they are well entrenched in particular sectors and are therefore described in the next section of this chapter or in Chapters 2 to 11 devoted to sector-by-sector study of the model.

C A Preview of the Main Features of RDX2

In this section we make the first references to equation numbers and variable names. Those who wish to take maximum advantage of our cunningly devised scheme for variable names ought now to consult the instructions at the beginning of Appendix A, which is in the other volume of this study - Part 2. There we explain how a good deal can be divined about the nature of a variable, as well as the units in which it is expressed, by referring to just the first letter in its name. We also explain

in Appendix A our set of notations, each preceded by J, for a number of simple algebraic operations.

In this section the twenty-one sectors of the model are described briefly under five headings. The sectors of the model are numbered from 1 to 21, and the equations within Appendix B (also in the other volume of this study - Part 2) are ordered by sector number and also by the number of each equation within that sector. For example, the behavioural equations in Sector 19 for long-term capital flows are numbered from 19.1 to 19.13. The technical relationships, mostly accounting identities that accumulate asset and liability accounts, are placed after the behavioural equations in each sector.

1 Private aggregate demand

This grouping consists of four sectors, comprising thirty-four behavioural equations and twenty-five technical relationships. Consumer expenditure (Sector 1) and residential construction (Sector 2) are discussed in Chapter 2. Investment and output (Sector 3) are taken up in Chapter 3, and foreign trade (Sector 4) is treated in Chapter 4.

The model of aggregate consumption expenditure employed in Sector 1 is based on expected wage income, expected nonwage income, the rate of return on savings, and capital gains and losses on equities and government debt. Estimates of disposable labour income are derived from income components of the national accounts and appropriate taxation statistics. Estimates of nonwage income are derived from the time series we have developed

on household wealth and relevant rates of return. National accounts estimates of consumption of services are modified to include imputed service flows emanating from household stocks of durable goods. The consumption equations are fitted in constant-dollar per capita form.

Expenditure on consumer durable goods is represented by two relationships: one equation for total expenditure on motor vehicles and parts and another for expenditure on all other consumer durables. In each equation we employ a stock-adjustment model, with the desired stock of durables depending on relative prices, wage income and nonwage income.

The residential construction equations in Sector 2 involve a split between single-detached dwellings and all forms of multiple dwellings. There are separate equations for housing starts and the related housing stocks of single-detached and multiple dwellings, and a combined equation for residential construction investment.

The business fixed investment equations in Sector 3 embody a flexible accelerator and cost-minimizing behaviour based on a pre-specified production function, vintage measures of capital intensity, expected output, and expected prices of capital and labour services. The prices of capital services depend on tax rates, depreciation rates, the supply price of capital, and the expected prices of capital goods. Stocks of machinery and equipment (KME) and of non-residential construction (KNRC) enter as separate factors into the production function. We chose the parameters of the production function after a search over a grid of alternatives. The demand for labour was obtained from the

same framework, after allowing for Harrod-neutral technical progress.

The production function is used along with actual inputs of capital, employment, and hours worked, to derive UGPPS, a measure of current supply of private nonfarm business output. UGPPD is a measure of desired output based on the labour supply rather than the current level of employment.

The inventory investment equation (also described in Chapter 3) has an 'intended' component based on a flexible accelerator that is driven by expected sales, and an 'unintended' component based on the excess of the supply variable, UGPPS, over non-inventory demand (UGPP-IIB). The latter component, multiplied by its estimated coefficient in the inventory equation, is used as a measure of unintended inventory accumulation or decumulation. This amount is subtracted from UGPP in order to obtain UGPPA, which we then use as our best measure of final demand. Thus we use UGPPA, rather than UGPP, as the driving variable in the business fixed investment equations, and UGPPA/UGPPD becomes the favoured index of imbalance between aggregate demand and supply.

In Sector 4 there are nine equations representing imports and exports of goods, thirteen equations for services, and nine technical relationships accumulating aggregate trade flows. Imports and exports of goods, estimated in constant dollars, are disaggregated both by commodity classification and by region of origin or destination. For this purpose we classify Canada's trading partners into two groups: the United States, and all other countries. Disaggregation by commodity is more extensive for imports than for exports. Imports of goods are divided into

as many as five separate groups, constructed from the ten basic Standard Industrial Trade Classification (SITC) classes, with transportation equipment separated for special treatment. Two principal benefits flow from the extensive disaggregation on the import side. First, disaggregation by region considerably improves our ability to explain the aggregate flow. Second, disaggregation by commodity reveals considerable information about the basic structure of the relationships involved.

The principal explanatory variables in the trade equations are: (a) the level of economic activity, domestic or foreign, (b) relative prices, (c) capacity utilization rates, domestic and foreign, and (d) qualitative variables generally used to describe special circumstances. In the case of imports the activity variable is a weighted sum of the components of domestic final demand, where the weights are based on the input-output coefficients reflecting import content, modified to suit the SITC commodity classification scheme.

The relationships explaining the levels of receipts and payments for various service flows also distinguish between Canada's two distinct trading regions. All these equations are estimated in current dollars. The relationships explaining travel payments and receipts, and freight and shipping payments and receipts are related to their 'natural' determinants - per capita consumption of services and trade flows, respectively. The interest and dividend payments and receipts equations provide an important link between the capital and current accounts of the balance of payments. Interest payments to the United States depend on the product of Canadian interest-bearing liabilities

and a weighted average of past Canadian and U.S. interest rates. The weights depend on new bond issues and the split between Canadian- and U.S.-pay securities. Dividend payments to the United States are derived from a distributed lag model applied to cash flow accruing to U.S. shareholders. The other interest and dividend flows are based on the applicable debt and interest rate series.

2 Private sector employment and wages, prices, and income distribution

Here we treat four sectors in three chapters. In Chapter 5 we deal with the equations of Sector 5 for employment and hours in the private sector. Chapter 6 contains a description of the Sector 6 equations for private sector wages and the Sector 8 equations for profits and dividends. In Chapter 7 we discuss the twenty-three price equations of Sector 7.

Employment in mining, manufacturing, and other business (NMMOB) is explained by a distributed lag adjustment towards desired labour input (NMMOBD) derived from the production function. NMMOBD is the quantity of labour that, working normal hours in conjunction with the actual capital stock, would yield a value of output equal to final demand (UGPPA). The deviation of average weekly hours in mining and manufacturing (HAWMM) from its normal value is then explained by the proportionate difference between actual and desired employment. Thus average hours worked represents the immediate adjustment mechanism. Employment and the capital stock adjust more slowly. Employment

and hours in construction are treated separately, since the sum of investment in residential and non-residential construction gives a separate activity measure for the construction industry. Employment in construction is explained chiefly by a moving average of construction activity, along with some additional impact caused by the deviation of current activity from its moving average, and the overall unemployment rate. Hours are determined primarily by the deviation of non-residential construction from its moving average. Here too, changes in hours represent a short-term rather than a long-term way of accommodating changes in labour requirements.

The main business wage rate equation, that for mining, manufacturing, and other business (WQMMOB), is based on a proportionate money wage response towards an equilibrium real wage determined mainly by labour efficiency, and to a lesser extent by the rate of unemployment and the expected rate-of-increase of consumer prices. This switch to an equation determining the real wage level means that there is no long-run trade off in the wage equation between the rate of unemployment and the rate of increase in the main business wage rate. The wage rate in construction (WQC) is obtained by a more usual percentage-change form strongly dependent on the unemployment rate and the expected rate of increase in consumer prices.

Our 'theory' of profits is implicitly embodied in our models of output, employment, investment, and price and wage determination. Thus the equation for corporate profits represents an attempt to approximate an aggregate business profit statement on the basis of current-dollar values of output, book

depreciation, employment expenses, and interest costs. The dividend equations embody lagged adjustments to changes in the relevant measures of after-tax profits plus book depreciation. Wage income is determined in Sector 8 by adjusting the wage bill for direct taxes and transfers to and from governments and non-residents. Gross private product is obtained from gross national product by subtracting accrued farm income, farm wages, and wage payments by all governments and noncommercial institutions. The result, YGPP, provides a reasonable approximation to the current-dollar output of the business sector.

Sector 7 contains twenty disaggregated price equations and three equations defining aggregate prices. In the latter we use a base-weighted aggregation for the Consumer Price Index (PCPI) and a current-weighted aggregation for the implicit deflators for gross national expenditure (PGNE) and private output (PGPP).

Investment and consumption prices are determined by a mixture of cost factors, the relationship between supply and demand, and sales taxes. The manufacturers sales tax is important in equations for the price of machinery and equipment and of building materials used in residential and non-residential construction. The two construction deflators are explained directly by labour and materials costs. Materials prices are affected by capacity utilization, normal unit labour and capital costs, and prices of forest products in export markets. The price of machinery and equipment depends heavily on the U.S. price, owing to the high import content of these products and the practice of pricing domestic output to match the landed price of imported substitutes. The consumption deflators are explained by

normal unit labour costs, import prices, short-term productivity, capacity utilization and retail sales taxes.

The Consumer Price Index is explained by a base-weighted average of a number of the implicit expenditure deflators. The aggregate national accounts deflators are determined exactly as they were originally derived - as ratios of current-dollar to constant-dollar expenditure totals.

Relationships explaining the various import prices contain weighted averages of foreign price deflators and the foreign exchange rate as their principal arguments. The weights themselves are determined by the commodity composition of Canadian imports. On the export side, prices are determined by world export prices, the U.S. private nonfarm output deflator, and a weighted average of Canadian aggregate demand deflators - the weights being governed by the commodity composition of Canadian exports.

3 The operations of governments

The six sectors under this heading will be described in Chapter 8 and in a forthcoming separate study [22]. The sectors for direct taxes (Sector 9), indirect taxes and other government revenues (Sector 10), and transfer payments to persons (Sector 11) are similar to those in RDX1, except that federal government revenues and transfer payments are treated separately from those of provinces and municipalities. For the equations in Sectors 9-11 we employ the models described in an earlier study of government sector equations [28]. Sector 12, federal government

wage rates, employment, investment, and other expenditures, and Sector 13 covering an even broader range of provincial and municipal items, represent a considerable amount of innovation. By treating as endogenous a wide range of government expenditures usually treated as exogenous, we made the simulation properties of RDX2 substantially different from those of other models. Our equations for these expenditure items typically involve policy variables as well as demand variables, so that one can assess the extent to which various employment, wage rate, and expenditure series have been used as policy tools and how much their movements have been dictated by demand for government services. The structure of these equations can be altered in various ways to simulate the consequences of different types of government reaction.

Sector 14 contains important accounting that links the current expenditures and revenues of governments to changes in foreign exchange reserves, government cash balances, and government debt of various kinds. These links are of great importance in specifying the various portfolio balance effects of alternative fiscal and monetary policy mixes.

4 The financial sector

The financial sector is comprised of the equations in Sectors 15 to 18 and is described in Chapter 9. Equations in Sector 15 include demand functions for liquid asset holdings of the private domestic nonfinancial sector of the economy. The estimation of these equations was carried out subject to

portfolio consistency constraints. Nine asset categories are used, including deposits in chartered banks, deposits in non-bank financial institutions, and government debt. The equations in Sector 16 for chartered bank assets determine the earning liquid asset ratio (RABEL), which is used in our measure of credit availability.

A variety of interest rates are determined by the equations in Sector 17. The basic interest rate in RDX2 is the short-term Government of Canada bond rate (RS), which is explained by means of a central bank reaction function rather than through a conventional money supply-demand model. Thus, we treat the interest rate as the primary target of monetary policy. Interest rates on deposits, mortgages and three additional maturity classes of government debt are also explained. The market value of the business capital stock, the supply price of capital, and the expected annual rate of change in the Consumer Price Index are jointly determined in Sector 18.

5 International capital flows and the foreign exchange market

Thirteen equations for international movements of capital in long-term form are in Sector 19, and the accumulation of international assets and liabilities is detailed in Sector 20. Both sectors are described in Chapter 10. In Sector 21 and Chapter 11 we present our model of the foreign exchange market.

Our two direct investment inflows to Canada, as well as the corresponding outflow to the United States, are estimated in Sector 19 as proportions of the net business financial

requirements of the borrowing country. These ratios are influenced by international differentials in the supply price of capital and sometimes by business borrowing requirements in the investing country and various special factors. Gross new issues of Canadian bonds sold in the United States are explained in two equations. In both cases the flow is estimated as a proportion of total borrowing requirements and determined chiefly by the tightness of Canadian financial markets rather than by interest rates on outstanding bonds. By way of contrast, trade in outstanding bonds and shares is generally explained in stock-adjustment models depending on rates of return on outstanding issues and portfolio proportions of lenders. In summary: direct investment decisions are assumed to be taken jointly with decisions to make capital expenditures in the borrowing country; new issues of Canadian bonds sold to U.S. residents depend on borrowing requirements and the ease of floating bonds in Canada; and all other flows depend primarily on rate-of-return differentials and the composition of the lenders' portfolios.

Sector 20 contains equations that cumulate capital flows into asset and liability positions. The most detailed accounting is used for claims by U.S. residents on Canadian assets or institutions. Holdings of government and of corporate bonds are separately cumulated at balance of payments book value. Direct investment is cumulated, along with retained earnings on direct investment, and regularly revalued according to changes in the replacement prices of Canadian assets. U.S. portfolio holdings of Canadian shares are separately cumulated and revalued.

Liabilities to other foreign holders of Canadian securities are cumulated and revalued on a more aggregated basis, the only split being between government bonds and other securities. Canadian holdings of foreign securities are built up, without revaluation, from the balance of payments flows. The asset and liability accounts are used in the explanation of international flows of interest and dividends, and in the determination of the market value of Canadian private sector wealth.

Sector 21 is described in Chapter 11, and simulation experiments with the sector are reported in [31]. There are separate behavioural equations for private and official excess demand for foreign exchange. The price of foreign exchange (PFX, in Canadian dollars per U.S. dollar) is then determined by the market-clearing condition. Private excess demand for foreign exchange is based on a stock-adjustment model that depends on lagged responses to the balance of trade and long-term capital flows, the covered differential between the Canadian short-term rate and a weighted average of U.S. domestic and Euro-dollar interest rates, the accumulated stock of Canadian net short-term liabilities to foreigners, and a special variable representing the speculative pressures on the Canadian dollar in 1Q68. Official excess demand for foreign exchange depends on a highly nonlinear model of the commitment to support the price of foreign exchange between two established support points, and a second exchange rate variable reflecting greater willingness to sell foreign exchange when the price is above par than to buy it when the price falls below par. This equation also contains a trading

strategy variable and the beginning-of-quarter difference between target and actual reserves.

The forward exchange market is represented by a reduced-form equation for its price; this equation includes the balance of trade and capital flows, the interest differential, a speculative variable, and net changes in the forward liabilities of the foreign exchange authorities.

In the remaining equations of Sector 21 we use the relevant balance sheet and balance of payments constraints to determine short-term capital flows, the level of reserves, and net short-term indebtedness between Canada and all countries.

This completes our capsule preview of the structure of RDX2. Chapters 2 to 11 contain more detailed descriptions of the various sectors, and we attempt in Chapter 12 to make some preliminary assessment of how the model works as a whole.

CHAPTER 2

CONSUMPTION AND RESIDENTIAL CONSTRUCTION

SECTORS 1-2

A The Framework for Analysis

1 Consumption vs expenditure

In RDX2 we make a firm distinction between consumer expenditure and the consumption of services by households. We start with the assumption that consumer expenditure on non-durables, semi-durables, and services is matched by consumption in the same quarter. By contrast, household expenditure on motor vehicles and other durables is assumed to add to the stocks of these goods, with the relevant consumption item defined as the services flowing from the stock of durables on hand. In the national accounts similar treatment is accorded to dwellings - expenditure is treated as part of investment and the corresponding consumption of services is defined as the rental on all dwellings, including an imputed rental on dwellings occupied by owners. In effect, we extend the national accounts treatment of dwellings to motor vehicles and other durables. This treatment required the construction of a new series for the imputed rental value of motor vehicles and other durables (CSMVOD).

We describe the two consumption equations (one for non-durables and semi-durables and the other for services, including CSMVOD) in section B of this chapter, the expenditure equations for motor vehicles and other consumer durables in section C, and the residential construction model in section D. The remainder of section A is devoted to the income and relative price concepts that underlie the consumption equations.

2 Types of income

We treat wage income, nonwage income, and revaluation gains and losses separately because of differences in methods of measurement, conceptual foundation, and the probable impact on consumption behaviour. Our chief innovation lies in the use of the components of our wealth series to define new series for nonwage income and for revaluation gains and losses.

2.1 Disposable wage income

The income components of this variable (YDW, defined in equation 8.6) include wages, salaries, and supplementary labour income, military pay and allowances, unemployment insurance benefits, other government and business transfer payments to persons, and the after-tax return from nonfarm unincorporated business. The items deducted in moving to disposable income include employer-employee contributions to social insurance and government pension plans (TRSIGPR+TUIRF+TCPPF+TQPPPM), personal income taxes deducted at source (net of refunds), hospital and

medical care insurance premiums, and all other direct transfers from persons to governments, with the exception of motor vehicle licences and permits. The main direct taxes not charged against wage income in our accounting are personal income taxes paid by instalments. Except for a small portion charged against the income of unincorporated business, these taxes are assumed to apply to nonwage income. This simplifying assumption accords fairly well with the facts, because in general only wages and salaries are taxed at source, whereas taxes on nonwage income are paid by instalments.

When the disposable wage income variable is used in the consumption equations, it enters with an eight-quarter polynomial distributed lag to capture the expectations process whereby the time series of current incomes is converted to an expected future income. We consider in section B what adjustments in scale must be made in order to interpret an average of past values of a growing earnings stream as a measure of expected lifetime earnings.

2.2 Disposable nonwage income

We make use of two measures of nonwage income, the smaller one based on the current national accounts data (personal disposable income minus disposable wage income), and the larger one, representing permanent disposable nonwage income, based on wealth components multiplied by imputed real rates of return. Both series are net of personal income taxes paid by instalments and all other direct taxes paid to governments with the exception

of income taxes and employer-employee contributions to social insurance and government pension plans. Our new measure (YPDNWP, defined in equation 8.11) is more than twice as large as the national accounts series, chiefly because YPDNWP takes into account a number of items not included in the national accounts definition of personal income - undistributed profits of corporations, as well as imputed income from monetary claims on the government, from motor vehicles and from other consumer durables.

The trickiest part of defining a permanent nonwage income stream from each component of wealth is finding a comparable standard of measurement when some returns are fixed in nominal terms and others grow with increases in the price level. The best examples to use are the interest on the public debt (including the direct and guaranteed debt of provinces and municipalities) and the earnings derived from resident-owned business fixed assets and inventories. As shown in section F of Chapter 9, if a growing profits stream (denoted by x), which is expected to grow at a rate g, accrues to the owners of business assets with a market value v, then the 'permanent' value of the earnings stream is x+gv. In terms of RDX2 variables, x+gv is equal to the nominal supply price of capital (RHO) times the market value of business assets (VKB). The expected value of interest on the public debt is more simply defined as being equal to the long-term rate of interest (RL) times the market value of the resident-held debt (VLGB11).

Although we can define permanent income streams in nominal terms for the various components of net household wealth, are

they what we want? If our consumption equations are to be fitted in constant (1961) dollars, then we shall want to define our nonwage income variable so that it can be deflated by the current value of the Consumer Price Index (PCPI) to obtain permanent nonwage income measured in 1961 dollars. To do this, all future values of the income stream must be expressed in prices of the period in which expectations are being formed. Put another way, we must subtract from each nominal rate of return the expected rate of price inflation g', before multiplying by today's asset value, in order to define a permanent income stream in terms of today's dollars. Reverting to the example used earlier, the permanent rate of return from business assets will be equal to $[(x+gv)/v]-g'$, or simply x/v if profits per unit of business assets are expected to grow at the anticipated rate of inflation (i.e. $g=g'$). In RDX2 terminology the expected permanent return from business assets, in today's dollars, is equal to the market value of assets (VKB) times the supply price of capital in real terms (RHOR, equal to RHO-PCPICE, where PCPICE is the expected rate of change in consumer prices). To measure the permanent return from government debt in terms of today's dollars, one must subtract from the nominal return (RL) the expected rate of inflation (PCPICE). By analogy with the argument in Chapter 9, if the interest stream x, in today's dollars, is expected to decline at the rate g, then the permanent return is $x-gv$, where v is the current market value of the bonds. In terms of RDX2 variables, the permanent stream is therefore defined as the real rate of interest (RL-PCPICE) times the market value of the public debt.

A parallel treatment is given to the imputed permanent income streams derived from most other components of household wealth. Foreign assets of Canadian residents are an exception, as the lack of asset values leads us to use recent average earnings to measure expected earnings. For dwellings, motor vehicles, and other consumer durables the imputed income is equal to a constant times the current replacement value of these stocks. The constant in each case is an estimate of the average real rate of return on savings. Ideally we should prefer to use current market values, but the replacement values of the depreciated stocks represent the best available.

Because we use replacement rather than market values for the stocks, we must use an average rather than a current value for RHOR as a measure of opportunity cost. Otherwise we would overstate the variance in expected nonwage income resulting from a change in RHOR.

A special case is posed by the non-interest-bearing debt of the federal government - the stock of 'high-powered money'. Here the imputed 'rental value' is measured by the opportunity cost RL-PCPICE, that is, the real rate of return one could get by investing in bonds rather than holding cash.

The theory underlying our treatment of household claims on governments is fairly conventional, but has some disturbing features. Private sector balance sheets are fully consolidated, but household claims on governments are treated as private wealth, and no account is taken of real assets owned by governments. Any increase in the public debt expands permanent nonwage income, unless taxes on nonwage income are raised enough

to cover the interest payments on the debt. If the interest payments are mainly financed by further debt issues (as is the case in the normal simulation context in which tax rates remain fixed), then expected permanent income rises regardless of the use to which the funds are put. If the funds are used to expand transfer payments to persons, then disposable wage income also rises and the whole process begins to resemble a sophisticated confidence trick. Perhaps when the costs and benefits of various government sector activities are more clearly measured it will be possible to lift the 'veil of government' and define private sector wealth (and therefore expected nonwage income) by reference to the asset side rather than the liability side of government sector balance sheets. These developments must await the next generation of macro-models, if not the next generation of theorists and model-builders. In the meantime, it is appropriate to conclude a soul-baring paragraph by noting a spot of double counting in our present procedures. The assets of government-owned business enterprises are included as part of the business capital stock, and the stock of direct and guaranteed government debt undoubtedly includes some issues used to finance investment in government-owned business enterprises. Because the form of the available data does not lend itself to consistent disaggregation, we accept what we hope is a fairly slight upward bias in our measure of expected nonwage income. The bias is likely to be slight because the profits of government-owned business enterprises are small in relation to total profits.

Taxes on nonwage income are measured by current tax accruals, so as to abstract from the lags and seasonality in the

tax collection process. The use of current tax accruals to represent future accruals, measured at today's prices, reflects the simplifying assumptions that taxable nonwage income is expected to increase at the same rate as nonwage income and that future tax rates are expected to be adjusted so that they absorb the same proportion of taxable nonwage income. We are considering methods of inflating the tax accruals series to embody assumed expectations more in line with historical experience.

2.3 Revaluation gains and losses

The meaning and purpose of our series for revaluation gains and losses (YKGP, defined in equation 8.12) are best introduced by contrasting our treatment of nonwage income and wealth with procedures used by other researchers. Previous theories making use of nonhuman wealth in aggregate consumption functions, whether emphasizing the role of wealth as potential consumption (as in life cycle models, e.g. [2]) or as a measure of permanent nonwage income [21], have been derived on the assumption of a constant discount rate. In RDX2 we have taken some pains to define variables for the supply price of capital in both nominal (RHO) and real (RHOR) terms. From the point of view of a saver investing in shares, the supply price of capital is the rate of return on savings - the discount rate used in establishing present values. If there is some variance in the discount rate used to value future income streams, then changes in the market value of wealth no longer have unambiguous meaning. An increase

in the aggregate market value of wealth can be generated by new savings, because there has been an increase in the stream of future earnings expected to arise from the existing stock of assets, or because there has been a drop in the discount rate. Consumption models employing the market value of wealth are valid only if the discount rate is unchanged and there are no other changes in the desired stock of wealth.

YPDNWP is defined as an expected nonwage income series to capture the income effect of wealth changes induced by changes in either the expected flow of constant-dollar earnings or in the discount rate. We also need a way of representing the revaluation gains and losses that arise if there are changes in the present value of expected returns from existing assets. We define this series as the change in the market value of wealth, net of savings in the current period. This definition measures capital gains, net of any changes in wealth attributable to changes in the desired stock of wealth effected by net current savings or dissavings.

The series for expected nonwage income and revaluation gains and losses embody between them both price-induced and interest-induced wealth effects. If the prices of all goods and services drop, with real rates of return unchanged, there will be a rise in the real value of our synthetic nonwage income series - a real balance effect of the sort emphasized by Patinkin [47]. Offsetting revaluation losses will, however, take place on those wealth components valued at replacement prices.

Any decline in the nominal rate of interest, with real rates of return unchanged, leaves the expected nonwage income from

bonds unchanged, but gives rise to capital gains on bonds because of changes in the bond valuation ratios. (See equations 14.2 to 14.5 described in Chapter 8.) These interest-induced capital gains (emphasized in theory by Metzler [42]) form part of our series for revaluation gains and losses. If an easier monetary policy leads to lower nominal and real rates of interest, then there will be revaluation gains on both bonds and shares. On the other hand, expected nonwage income will fall as debts mature and are refinanced at the new lower rates of interest. The net impact on consumption will depend on the relative importance of nonwage income and revaluation gains in the consumption equations, as well as on the effects of the lower rates of interest operating through other routes - relative prices, savings, investment, and foreign capital flows.

3 Savings and the rate of return

For given tastes, profiles of expected wage incomes, and stocks of wealth the decision whether to consume now or later rests upon expected changes in prices as well as the available rate of return on savings. The net incentive to save is measured in RDX2 by RHOR, which is equal to the nominal rate of return on savings (RHO) less the expected rate of increase in consumer prices (PCPICE). RHOR is defined after deduction of corporation tax but before personal tax, so that no account is taken of any changes in the personal tax treatment of investment income. We tried RHOR in both consumption equations, but found a strong intertemporal substitution effect only in the equation for non-

durables and semi-durables. The rate of return on savings also influences the purchase of motor vehicles and other consumer durables by appearing in the relative price term described below.

4 Relative prices

Relative prices influence consumption indirectly, as they play important roles in the expenditure equations for motor vehicles and other consumer durables. Changes in expenditure on motor vehicles and other consumer durables alter the stocks of those assets and hence alter both the imputed consumption of services from motor vehicles and other durables, and the expected stream of nonwage income.

The relative price terms in the expenditure equations are ratios of the implicit rental price for the durable to the current-weighted average of the prices of services, non-durables, and semi-durables. The rental price is defined as the purchase price of the durable times the sum of a quarterly depreciation rate and a series equivalent to the quarterly supply price of capital in nominal terms. The denominator of the relative price ratio should perhaps be defined as an expected price, over a horizon equal to the average lifetime of the consumer good. This treatment would be analagous to that adopted in the factor-demand equations explained in Chapter 3. An alternative procedure in the present case would be to define the rental price of the durable to take account of expected capital gains, i.e. to use RHOR rather than RHO as the supply price of capital. In the next version of RDX2 one of these alternatives to the present

definition of relative prices will probably be adopted, although we suspect that neither of them will do much to alter the coefficients or the simulation properties of the equations.

B Consumption Equations

1 Description

CNDSD Consumer expenditure on non-durables and semi-durables (Equation 1.1)

The dependent variable is the expenditure series, in 1961 dollars, divided by the non-institutional population fourteen years of age and over (NPOP). The independent variables include expected nonwage income, the real rate of return on savings, an eight-quarter distributed lag on disposable wage income, a constant, constrained quarterly variables times the lagged dependent variable, and the difference between the national accounts measure and our synthetic measure for nonwage income. All the income variables are deflated by the product of NPOP and the Consumer Price Index, so that they are, like the dependent variable, on a real per capita basis. The revaluation gains variable was tried, but did not improve the equation. All the income variables used and the rate of return on savings have significant coefficients. We found the statistical properties of the equation as a whole to be quite satisfactory. The coefficient of variation is only 1.01%, and there is no apparent autocorrelation of residuals.

The only variable appearing in the equation without being heralded in the previous section is the difference between the national accounts measure and the RDX2 measure of nonwage income. There are three possible justifications for this variable. The most obvious interpretation is that it is a measure of transitory nonwage income because of the attempt in the national accounts to measure current income received, whereas our YPDNWP is an approximation of permanent nonwage income. The second possibility is that there are measurement errors in both series, and so the inclusion of both helps to avoid the downward bias in coefficients caused by independent errors of measurement. The third interpretation emphasizes the fact that the RDX2 concept of nonwage income is over twice as large as the disposable national accounts series, has more imputed components, and is not so closely related to current cash receipts. If the third justification were the most relevant, one would expect to find a coefficient on the national accounts series greater than on the RDX2 series. In fact the implied coefficients on the two nonwage income variables are nearly the same in this equation, and higher on the RDX2 series in the services equation.

The coefficient of -608.8 on RHOR implies an elasticity for this consumption category of -.14 with respect to changes in the real rate of return. Because CNDSD is about five times as large as personal savings, the implied rate-of-return elasticity of savings is about .70. This is, of course, a substitution effect, which could be cancelled out by offsetting income effects. The implications of the income coefficients are outlined below in section B.

CS+CSMVOD Consumer expenditure on services, including imputed services from the stock of motor vehicles and other consumer durables (Equation 1.2)

The dependent variable is the sum, in real per capita terms, of consumption of services as defined in the national accounts, imputed services from consumer motor vehicles as well as other consumer durables used by their owners, and medicare payments made by provinces. Income variables include those used in the non-durables equation plus a seven-quarter lag distribution on the revaluation gains variable. The rate of return on savings did not enter the equation. Apparently the negative interest elasticity of CMV and CDO filtering through into CSMVOD is offset by changes in the volume of purchased services. The equation also includes a dummy variable covering the second and third quarters of 1967, and accounting for an apparent underrecording of service expenditure by residents during Expo67.

Taken as a whole, the equation fits well, with a coefficient of variation of only .63% and no significant autocorrelation of residuals. Revaluation gains appear to influence consumption only slightly, with a sum of weights of merely .026. However, changes in expected earnings cause a large proportion of capital gains, and both of the nonwage income variables have large and strong coefficients.

2 Interpretation of Equations 1.1 and 1.2

The equations discussed above will be re-estimated shortly, with 1969 added to the sample period, data changed because of

forthcoming historical revisions to the quarterly national accounts, and consistent estimation methods used to reduce the possibility of simultaneous equations bias. In the meantime, interpretation of the present coefficients may help to shed some light on the income and consumption concepts underlying our equations.

It is useful to consider the effects of a change in income on total consumption. An increase in disposable wage income of $100 will lead, over the following eight quarters, to an increase in consumption of $82. The rest finds its way into savings, and thus generates a larger stream of expected and current nonwage income.

Expected wage income, in terms of today's dollars, may be either higher or lower than our eight-quarter average. On the one hand, the real wage rate grows at about the same rate as the labour efficiency factor (ELEFF). On the other hand, the consumption horizon of each wage earner is longer than his earning horizon for wage income. We have made no estimates of the probable net effect of these two influences.

An increase in nonwage income has different effects depending on the form it takes. If dividends from Canadian corporations to taxpaying persons rise, with current and expected profits unchanged, then accrued taxes rise according to the current average rate paid on nonwage income, less the dividend tax credit. For every $100 that gets into disposable nonwage income, consumption rises by about half that amount. If current and expected profits rise by $100, with dividends unchanged, consumption rises by $66. If current and expected profits

increase by \$100 and average payout ratios and tax rates apply, about \$85 extra will be spent on consumption, excluding the small effects flowing through the capital gains term.

C Expenditure on Motor Vehicles and Other Consumer Durables

1 Theoretical structure

Both durables equations are estimated in a capital stock-adjustment framework with gross expenditure as the dependent variable. If replacement investment is hypothesized to be some fraction of the lagged stock, then the expenditure equations have the following form, using CD to represent expenditure on a consumer durable and KDD to represent the desired stock:

$$CD = b(KDD-J1L(KD)) + c(J1L(KD))$$

In our applications of this model, the desired per capita stock (KDD) is made a linear function of income variables, relative prices, and a constant term. To derive an estimate of the adjustment parameter, b, we must make some assumption about the size of the replacement coefficient, c, because the coefficient on the lagged capital stock is an estimate of c-b. There is no theoretical requirement that the coefficient c should be the same as the exogenous depreciation rate used in constructing the stock series. However, this assumption, which

we use below in interpreting the results of our equations, is convenient and fairly harmless.

2 Estimated equations

CMV Consumer expenditure on motor vehicles and parts (Equation 1.3)

Gross expenditure on consumer motor vehicles, in constant dollars per capita age fourteen and over (NPOP), is the dependent variable. The determinants of the desired stock of consumer motor vehicles are expected nonwage income, an eight-quarter lag distribution on disposable wage income, and relative prices. The income variables are deflated by the product of NPOP and the Consumer Price Index. As outlined in section A, the relative price variable has the implicit cost of car ownership in the numerator and a weighted average price of non-durables, semi-durables and services in the denominator. The high coefficient on the lagged stock indicates a fast expenditure response to changes in the desired stock of cars. If the replacement coefficient c is taken to be equal to the depreciation rate of .055 per quarter, then the estimated coefficient of adjustment is about .41 per quarter.

Taking the adjustment coefficient as given, we can calculate the elasticities of the equilibrium stock with respect to its determinants, using the estimated coefficients and the sample means of the variables. These elasticities are 1.94, .22, and -.20 with respect to changes in disposable wage income, expected nonwage income, and relative prices, respectively. Also relevant

are the impact elasticities of expenditure with respect to changes in the current period's disposable wage income, expected nonwage income, and relative prices. These elasticities are respectively 3.37, 1.22, and -1.09. The impact elasticity of CMV with respect to changes in RHO is about one-fourth as large as that for relative prices, because RHO is about one-third as large as the constant depreciation rate entering the relative price term.

As might be expected, given the volatility of investment expenditure in general and of the car market in particular, the equation as a whole does not fit as closely as do the consumption equations. It has a coefficient of variation of 7.04%, and an RB2 of .939.

CDO Consumer expenditure on durables (excluding motor vehicles and parts) (Equation 1.4)

In this equation we make use of four rather than two income measures. Otherwise it is similar in structure to the motor vehicles equation. The two additional income variables are the difference between measured and expected nonwage income, and a seven-quarter distributed lag on the series for revaluation gains and losses. The four income variables used are therefore exactly the same as those appearing in the equation for the consumption of services. We attempted to achieve similar parallelism in the motor vehicles equation, but measured nonwage income and revaluation gains had no apparent effect.

Although relative prices and all the income concepts play suitable roles in the CDO equation, the coefficient on the lagged

stock is so low as to imply a much slower stock adjustment than for motor vehicles. If we assume once again an equivalence between the replacement coefficient and the assumed depreciation rate, the implied value for the adjustment coefficient b is only .084. This may well be an underestimate of the speed of adjustment, perhaps because of an upward trend in the desired stock attributable to steady increases over time in the variety of consumer durables offered. Perhaps we ought to have guessed in advance that the stock of refrigerators built up over past years would not dampen this year's demand for snowmobiles.

We calculated the equilibrium elasticities, measured at sample means, of the stock of other durables with respect to relative prices and to the four income variables. They are -.67 for relative prices, 1.20 for disposable wage income, .005 for the RDX2 concept of expected nonwage income, .21 for national accounts nonwage income, and .006 for revaluation gains and losses. Current-period expenditure elasticities, following the same order, are -.792, .421, .006, .248 and zero. The current impact elasticity is zero for revaluation gains because this variable enters the equation with a distributed lag and has a coefficient of zero in the current period. Only the current-period weights are used in calculating the impact elasticities. The equation fits quite well, with a coefficient of variation of 1.99% and an RB2 of .984.

In summary, the RDX2 equations for consumption and expenditure on consumer durables fit well and give fairly reasonable roles to wage income, the rate of return on savings, the prices of durable goods, and expected income from the

components of wealth. We are, however, uneasy about the relationship between our two concepts of nonwage income. When both variables are used, some components of nonwage income are counted twice and others only once. We expect to reorganize our treatment of nonwage income in the next edition of RDX2, possibly in a way that takes account of the different degrees of liquidity of the various components of wealth and nonwage income.

D Residential Construction

1 Private investment in residential construction

The main variable explained in Sector 2 is private investment in residential construction (IRC). One can obtain better results for this equation by treating single-detached and multiple dwelling starts separately. This is so, because single-detached houses can be more quickly constructed than high-rise buildings of multiple units, and the average single unit gives rise to a larger expenditure than the average multiple unit. Equation 2.1 for IRC shows the lag pattern of expenditures following starts to be more complex, as well as longer, for multiples. The lag distribution for singles has declining weights over four quarters. The lag distribution for multiples is spread over five quarters and has two peaks, presumably because multiple starts are a mix of two main types of housing with sharply differing construction periods. One type, comprising semidetached dwellings, row housing, and similar

structures, can be built as fast as single-detached dwellings, but for construction of the other type, high-rise apartments, much more time is required. Thus the peak in the current quarter represents mainly expenditure on row housing and so on, whereas the peak in quarter t-3 probably represents mainly expenditure on high-rise construction.

The basic assumption underlying our regression of constant-dollar expenditure on housing starts is that each type of housing start gives rise to a fixed amount of constant-dollar expenditure. If the size or quality of dwelling units changes over time, our procedure will be suspect. We should like to take quality changes into account, but the available data do not permit us to do so. For one thing, the national accounts expenditure data are constructed without reference to the size of houses. In addition, the only available index of the size of new units is that for the floor area of new houses financed under the National Housing Act (NHA). The variance of this series is a misleading measure of house size because changes over time in the permitted maximum value of NHA mortgages and in construction prices alter the relationship between the size of the average new house and the size of the average new NHA-financed house.

The IRC equation fits well, with an RB2 of .964 and a standard error of $17.9 million. If the equation is fitted using total housing starts rather than the component series, the standard error rises to $21.6 million.

2 The supply functions approach versus the reduced-form approach to the determination of housing starts

In specifying the RDX2 equations for housing starts, we made substantial use of the model developed for RDX1 by Lawrence B. Smith [51]. A central feature of Smith's approach is the treatment of housing starts equations as supply functions for builders. Thus, prices and rents relative to construction costs play a key role as measures of the profitability of new construction projects. Similarly, credit conditions are a determinant of the rate of return on equity in rental units and of the imputed rental cost of owner-occupied units. In the case of speculative single-family housing projects, credit conditions are viewed as influencing builders through the cost and availability of temporary or bridge financing and through the anticipated influence of carrying charges on prospective buyers.

In view of the difficulty of obtaining an appropriate measure of housing prices ([51] pp.11, 17), as well as certain problems encountered in extrapolating Smith's model so as to explain more recent behaviour, we decided to use a market reduced-form approach. In the present specification, the price term is solved out and replaced by determinants of final demand. Demand in terms of the desired stock of units is assumed to depend on the price of housing, real disposable income per household (in distributed lag form), and credit conditions. Separate equations are included for starts of single-detached dwellings (HSTS) and multiple dwellings (HSTM), with the dependent variable in each case divided by the number of

households and the lagged stock entering as a determinant of the demand for new units.

In the fitted equations income was dropped from the single unit equation (equation 2.2) because it failed to enter significantly, but the lagged stock entered both equations as expected. The other variables used were measures of credit conditions (discussed in the next section), and a dummy variable (ZWW) to allow for the winter building incentive programme in effect from 3Q63 to 2Q66. The latter variable entered linearly and interacted with seasonal dummies to measure the seasonal shift in starts induced by this programme. The representation of final demand remains a somewhat unsatisfactory aspect of our housing starts model. In particular, we have probably inadequately explained the substantial increase in the proportion of multiple unit starts that occurred during the 1960s. Land costs, as introduced by Smith, and some demographic variables were tried with little success.

2.1 Housing starts and credit conditions

Several variables are used to represent the cost and availability of mortgage credit as well as the influence of short-term credit conditions on builders.

The interest rate on conventional mortgages (RMC) is used as the measure of the cost of mortgage credit. This rate enters significantly in equation 2.2 for single-detached units. Following Smith, we tried the differential between the mortgage rate and the bond rate as a measure of the availability of

institutional mortgage financing. However, this variable did not enter significantly. As an alternative to this interest differential we tested the four-quarter change in assets of trust and loan companies [J4D(ATL)] since this change was found to be significant in the mortgage lending equations (equations 17.9 and 17.10, described in Chapter 9). It enters the multiples equation significantly.

As in Smith's model, mortgage approvals for singles (HAPCMHCS) and for multiples (HAPCMHCM) made by Central Mortgage and Housing Corporation (CMHC) were tested. HAPCMHCM enters the multiples equation significantly and although no direct role for HAPCMHCS has been found in equation 2.2, there are indirect effects of CMHC approvals for single-detached dwellings on HSTS since HAPCMHCS is one of the determinants of RMC (see equation 17.8) and RMC affects HSTS directly.

We also tested a dummy variable (QNHA) to allow for a change in structure with the removal of the ceiling on the NHA mortgage rate in 1967. (See Chapter 9, section G.) QNHA enters the multiples equation with a significant coefficient.

Finally, the measure of credit availability based on the chartered bank earning liquid asset ratio (RABEL) enters significantly in both the singles equation and the multiples equation.

3 Stock of dwellings

SHS Stock of single-detached dwellings (Equation 2.4)

This equation is estimated in first-difference form to remove the strong trend influence. We intend the equation to reflect the combined effect of completions of new houses, conversions of houses from single to multiple occupancy, demolitions to make way for new construction, fire loss, and scrapping. The coefficient on the lagged stock shows an annual proportional rate of decline of almost 2%, presumably comprising mainly conversions plus demolitions. The sum of the coefficients on lagged starts is .856, probably less than 1 because of demolitions to make way for new buildings. The standard error is 2,451 units, about .07% of the average stock in 1968.

SHM Stock of multiple dwellings (Equation 2.5)

This equation is also estimated in first-difference form. The lagged stock does not enter the equation, but there is a significant positive constant term, which presumably represents the effect of conversions from single to multiple occupancy. The sum of the coefficients on multiple starts is about .62, too low to be believed as a partial result. If the negative coefficient on the current quarter's starts is ignored, the sum rises to .92. Could it be necessary to demolish three units in order to make room for ten?

One may perhaps wonder why it is not possible to be more precise about the size of the housing stock. We constructed our housing stock series by using the results of quinquennial

censuses of the number of housing units. From one bench mark to the next we accumulated the stock by adding newly completed units and by adjusting it to take account of identified conversions and demolitions. The discrepancy between the accumulated series and the next bench mark is allocated evenly over the quarters between the census dates. We therefore have an approximate relationship between starts and the estimated stock, and are not surprised to find an imprecise conversion of starts into the resulting stock of housing. In terms of the housing model as a whole, the effect of coefficients summing to less than 1 on starts in equations 2.4 and 2.5 is to increase the number of starts resulting from a given change in any determinant of the desired stock in equations 2.2 and 2.3.

Equation 2.5 has an RB2 of .549, and a standard error of 3,340 units, about .15% of the average 1968 stock of multiple dwellings.

CHAPTER 3

BUSINESS INVESTMENT AND OUTPUT

SECTOR 3

A Introduction

This chapter contains the theory underlying our model of the interrelated demands for capital and labour, a discussion of our estimated business capital accumulation equations, and a catalogue of the various associated measures of output, aggregate demand and supply, and capacity utilization.

In the model of interrelated factor demands we treat three factors explicitly: the stock of business non-residential construction; the stock of business machinery and equipment; and total paid hours worked in mining, manufacturing, and other business. We assume that these inputs are combined within a three-factor Cobb-Douglas production function with constant returns to scale and Harrod-neutral technical progress to produce UGPP, the RDX2 concept of business output. UGPP is obtained by subtracting from constant-dollar gross national expenditure the total of constant-dollar farm wages, accrued farm income, plus wages paid in public administration, defence, and all noncommercial institutions.

We suppose also that the aggregate business economy never operates exactly on the efficient frontier represented by the aggregate production function, and that at least some of the

apparent discrepancy is attributable to abnormal rates of utilization of either type of fixed capital stock, or of employed labour. Since independent estimates of the degree of utilization of existing capital and employed labour are unobtainable, it is not feasible to estimate the aggregate production function directly. We therefore use a variety of sets of production function parameters as a priori inputs to distributed lag labour and capital adjustment models. The final choice of production function parameters is based on a combination of a priori plausibility (the production function elasticities should be consistent with income shares) and the accuracy of the derived investment and employment equations. The theoretical basis for the model is outlined in section B, and the derived equations for business fixed investment are discussed in section D. The equations explaining employment and hours are contained in Sector 5 and described in Chapter 5.

Once one has an aggregate production function for UGPP, one can derive several useful synthetic measures of actual or potential output. For example, if actual capital, the 'potential' labour force and 'normal' hours are put into the production function one obtains a measure of 'desired' output (UGPPD), conditional on ex post factor substitutability and on the use of the average level of factor utilization over the data period as a proxy for the unknown desired level. The production function may also be used with actual capital, hours, and employment as inputs. This procedure gives us a synthetic aggregate supply variable (UGPPS) measuring what output would be

in the current period if there were no offsetting short-term changes in factor productivity.

This aggregate supply variable plays an important part in helping to define the buffer-stock role of inventories, a matter taken up in detail in section C where we deal with the aggregate inventory equation. One by-product from our more precise definition of unintended inventory accumulation is a new concept for aggregate demand, UGPPA, equal to actual output less unintended inventory accumulation. Expectations about future values of this variable are what drive the business fixed investment equations, reported in section D. The availability of an appropriate measure of final demand also allows us to solve the production function for the level of employment desired by producers faced with given capital stocks. This desired level of employment (NMMOBD) drives the main employment and hours equations, described in Chapter 5.

To complete the chapter, we present in section E a catalogue of the various concepts of supply, demand, and capacity utilization derived from our model of production and investment and used throughout RDX2.

B The Basic Model

Interrelated factor demands are fun. They either will be or already are fashionable in macroeconomic applications ([12], [46]), but they are very messy. Once one starts down the road toward acknowledging imperfect foresight and costly adjustment,

one finds that everything is related to everything else. For example, if both capital and labour are adjusted only with time lags, and if there are limits to short-term changes in productivity, then it may be a mistake to use actual output as a basis on which to form expectations about desired future output [23]. For our initial experiments, however, we assumed that we could roughly compensate for any such measurement errors by suitable adjustments in the parameters of the expectations process on UGPP. We subsequently derived a measure of unintended inventory accumulation and now use the aggregate demand variable UGPPA as a basis for expectations about desired future output.

Nobody has yet been rash enough to consider a full neoclassical framework in which output and all factor inputs are determined solely by expected relative prices. There are too many measurement errors, too many dangers in aggregating across diverse products, too many non-clearing markets, and too much heterogeneity in expectations to allow this procedure much chance of success. Most of the models referred to as neoclassical (such as those of Jorgenson, e.g. [37]) avoid these difficulties, in part, by suppressing one relevant factor price (the wage rate) and then introducing the level of output as an exogenous variable entering into a flexible accelerator investment model. In these models the desired capital/output ratio depends only on the relative price of capital services and output. This procedure is rationalized by an assumption that the labour input can be easily adjusted in the short run to meet fully any changes in desired output. The actual level of output is presumably then decided by taking as given the price of output, the price of labour

services, and the amount of the existing capital stock. We were denied access to this approach because of our belief that both capital and employed labour are relatively fixed factors.

Our procedure has therefore been to assume cost minimization ([12], [41]), thus combining the demand for labour and the demand for capital in a single decision process depending on the expected price of capital and of labour services. These factor demands also depend on expected output. In the first stage we defined expected output by using UGPP and the parameters of the best expectations process derived in our previous study of expectations in investment behaviour [29]. We made use of UGPPA, the aggregate demand concept explained in section C below, in our final equations.

1 Costs to be considered

We take account of three separate inputs to the production function: labour in terms of man-hours of standard efficiency (named HEFF for the exposition in this chapter), the stock of machinery and equipment (KME), and the stock of non-residential construction (KNRC). We do not have the stock of inventories (KIB) entering directly; consequently the role of inventories in the production process remains rather vague.

Static optimization with respect to the factor inputs mentioned above requires that the relative cost of each pair of inputs should be proportional to their marginal physical products. We postpone for several paragraphs the problems

involved in applying such a model in the presence of time lags and uncertainty.

If the hypothetical production function is

$$UGPP = A\ [(KME)^{**}a]\ [(KNRC)^{**}b]\ [(HEFF)^{**}c]$$

and the implicit rental costs of KME and KNRC, as percentages, are RCME and RCNR, respectively; and if the hourly wage rate after corporation tax is (WQMMOB/13 HAWMM)(1-.01 RTCA), shortened to WH for this exposition; then we can use the marginal conditions to solve for the desired ratio of output to any of the factor inputs.

Thus, since the ratio between any two factor inputs is of the form, e.g., HEFF/KME = (c/a)(.01 RCME/WH), we can use the production function to solve for the capital/output and labour/output ratios as follows:

$$KMEY = \frac{1}{A}\left(\frac{a}{b}\right)^{b}\left(\frac{a}{c}\right)^{c}\left(\frac{WH}{.01\ RCME}\right)^{c}\left(\frac{.01\ RCNR}{.01\ RCME}\right)^{b}$$

$$KNRY = \frac{1}{A}\left(\frac{b}{a}\right)^{a}\left(\frac{b}{c}\right)^{c}\left(\frac{WH}{.01\ RCNR}\right)^{c}\left(\frac{.01\ RCME}{.01\ RCNR}\right)^{a}$$

$$\text{Desired}\left(\frac{HEFF}{UGPP}\right) = \frac{1}{A}\left(\frac{c}{a}\right)^{a}\left(\frac{c}{b}\right)^{b}\left(\frac{.01\ RCME}{WH}\right)^{a}\left(\frac{.01\ RCNR}{WH}\right)^{b}$$

Before we consider how this framework might be applied in a dynamic context with uncertainty, we ought to conclude the discussion of costs with a short explanation of the rental prices of capital services (RCME, RCNR). The concept is quite simple:

the implicit rental price is a fraction of the replacement price, where that fraction depends on the (combined) rate of depreciation and obsolescence, and on the supply price of financial capital (represented by a weighted average of RHO and RHO2, the measures of the Canadian and U.S. supply prices of capital) less an approximation to what can be recovered by way of deductions under the corporation income tax. RCME and RCNR thus represent rental prices after corporation income tax. Personal income tax enters only to the extent that it influences RHO, the required rate of unlevered pre-personal-tax return that must be paid in order to lodge domestic business shares in the portfolios of residents and non-residents. The formulae for the rental prices can be derived either by analogy with actual rental markets, or from the maximizing conditions for the revenue function of an owner-user of capital goods. Our expression for implicit rental prices is simpler than some such expressions, because we have converted several disparate tax allowances for depreciation into a single present-value series measured as a proportion of the price of capital goods. (A similar procedure has been used by Hall and Jorgenson in [25], p.16.)

Equations 3.9 and 3.10 give the exact expressions for the two rental price variables. The expectations weights on the investment prices determine the expected price of the capital good at the midpoint of the construction period. These weights are derived from the expectations process used in [29]. The second term in each equation shows the proportion of the cost of the assets that is not recoverable by means of corporation income tax reductions. In equation 3.9, for example, if the corporation

tax rate (RTCA) were 100% and if all assets could be charged immediately against taxable income (e.g., CPVME = .50), then the implicit after-corporation-tax cost of IME would be zero. The normal value of CPVME, the present value of tax reductions due to depreciation allowances, is .3333, based on a declining balance depreciation rate of 20% per year, a discount rate of 10%, and an assumed marginal tax rate of 50%. The actual value of CPVME rises above or falls below .3333 if any special tax measures that alter allowable depreciation are in force. (For a history of these various special tax measures and the derivation of CPVME and CPVNR see [18], pp.66-69.)

The third term in each expression is the sum of the quarterly depreciation rate (as derived and interpreted in [18], pp.9-13 and p.59) and the tax-adjusted cost of capital. The nominal supply price of capital is measured before personal tax but after corporation tax. The supply price of capital is represented in these equations by a weighted average of RHO and RHO2, with weights depending on the proportion of the stock of Canadian business fixed assets and inventories (KB$, measured at replacement prices) financed by U.S. direct investment (LDIRV12, also measured at replacement prices). Why do we need to use RHO2 at all, if RHO represents the Canadian supply price of capital? The reason is that our sample of shares used in constructing the share market value of Canadian fixed assets and inventories includes only shares traded on Canadian stock exchanges. What ought we to assume about the supply price of capital for Canadian investments directly financed by U.S. parent companies? We have assumed that the U.S. supply price of capital is more relevant

than the Canadian price for these ventures. In short, the current weights attached to RHO and RHO2 depend on the financing patterns followed in previous periods. The weights respond over time so as to attach more importance to the lower of the two supply prices of capital. This shift in weights occurs because the proportion of new capital expenditures financed by U.S. direct investment drops when the U.S. supply price of capital is high relative to RHO.

Since interest payments are deductible under the corporation income tax, and since dividends and retained earnings are not, we reduced the weighted average of RHO and RHO2 by a proportion determined by the corporation tax rate and the amount of the total return to capital taking the form of interest payments. The supply price of capital used in these equations is the quarterly counterpart to the annual rate. Thus, in its final form, RCME represents the imputed cost of IME as a proportion per quarter, and has a pronounced upward trend, starting at about 3.9% in 1955 and reaching a peak of 6.3% in 4Q66.

The corresponding variable for INRC is similar, except that the combined quarterly rate of depreciation and obsolescence is .01 instead of .05. The expectations weights are different because of the longer construction period, and the price and tax policy variables used are those appropriate for INRC. Because of the lower depreciation rate for KNRC, the imputed rental cost for non-residential construction (RCNR) is proportionately more dependent on the supply price of capital. RCNR is about 2.0% in 1955 and reaches a peak of 3.5% in 4Q66.

In the basic model, as described to this point, we determine desired values for the various inputs to the production function. These desired values are conditional upon known values for desired output and factor prices and upon the assumption that there are no lags or costs in the adjustment process. These conditions must now be relaxed.

2 Expectations and expenditure lags

In [29] we employed a model providing for full interaction between expectations and expenditure lags. That procedure required, for each type of investment, twice as many equations as there are quarters in the expenditure lag distribution. To hold down the number of equations required for RDX2 we simplified the approach in order to keep the expenditure and expectations processes related but functionally separate. We used the length of the investment lead time (i.e. the time from investment decision to completion of a project) to determine the future date to serve as a focus for expectations about factor prices.

In order to restrict the scale of our current experiments, we assumed that the results of our earlier investigations into expenditure lags [18] and expectations processes [29] are still valid for IME and INRC. These results are combined in RDX2 by assuming that expectations become operative only when projects are initiated, and that all subsequent alterations to the resulting time path of expenditures can be represented by special variables entering the investment equations separately. This is a similar framework to that used in the RDX1 equations [34], and,

as before, we allow for the possibility that some influence may be exerted by financial variables during the expenditure process.

By supposing that expectations are formed when a project is initiated, we can develop time series for desired capital stocks closely analagous to those of the static model. At any point in time, the desired capital stock that matters is the stock needed j periods ahead, where j is the length of the expenditure process. The expectations governing the choice of desired stock are those of desired output j periods hence, the price of fixed investment j/2 periods hence, current tax rates and tax provisions (current policies are therefore implicitly assumed to be long-lasting), and wage rates j+m periods hence, where m is the half-life of the building or equipment.

Wage rate expections are formed further into the future than capital goods prices because capital goods prices are fixed at the time of purchase, but labour is employed at wage rates that change continually during the life of the capital equipment. Therefore an addition to the expected rate of increase in prices and wages will increase the ratio of expected wage rates to expected capital equipment prices, and will lead firms to an immediate substitution of capital for labour in order to substitute capital equipment at 'today's' (t+j/2) prices for labour at 'tomorrow's' (t+j+m) wage rates.

Expectations about desired future output are for UGPPA twelve quarters hence in the case of INRC, and eight quarters hence in the case of IME. These horizons are equal to j+1, because each quarter's output is assumed to depend on the capital stock in place at the beginning of the quarter. In both cases

the expectations are based on actual values of UGPPA during quarters up to but not including the current one. The parameters of the expectations process are the same as those chosen in [29], but we use the mean quarterly growth rate of UGPPA 1Q52-4Q68 for g (see below). The expectations process takes account of extrapolative, regressive and trend-growth elements. The parameter g is the assumed trend rate of growth, and b represents the weight attached to the extrapolative element relative to the regressive element in expectations. The extrapolative and regressive elements attach exponentially declining weights to previous changes and levels, respectively. The parameter e represents the proportionately declining weight for the extrapolative element, and r represents the corresponding parameter for the regressive element. The parameter values used in the UGPPA expectations process are g = .0123, b = 1.5, e = 0.9, and r = 0.6.

The expectations about wage rates are generated by a slightly different process because they look so far ahead - twenty-three quarters for IME and seventy-eight quarters for INRC. The implied half-lives for investment goods (sixteen quarters for IME and sixty-seven quarters for INRC) are calculated by applying the assumed depreciation rates, 5% per quarter for IME and 1% per quarter for INRC. The expectations weights are the current-period weights (based on the expectations process with g = .0128, b = 1.5, e = 0.9, r = 0.6) multiplied by (1+g)**(j+m).

Our simplifications have thus enabled us to retain the key elements of the expectations mechanisms for prices and output,

while at the same time keeping the number of equations to a minimum. Next we consider how to move from desired capital stocks to desired investment.

3 Factor substitution, ex ante and ex post

To what extent are factor proportions embodied in capital equipment and buildings? Expected factor prices change over time, hence there will be changes over time in the optimal capital/output ratios, KMEY and KNRY. When firms compare the existing capital stock to the desired future stock, do they calculate the productive capacity of existing equipment by using the desired capital/output ratios applicable when the capital was built, or by using ratios based on presently expected factor prices? This question did not matter much in the context of either the RDX1 investment equations or those in [29], since the desired capital/output ratios were slow-moving trends. Now that we are making the desired capital/output ratios endogenous variables these issues must be faced.

We have tested both vintage and nonvintage versions of our factor-demand equations for capital and labour. The vintage approach is feasible chiefly because we use exponential decay depreciation rates. If we had made an alternative assumption that the capital stock was comprised of 'one-hoss shays', the problem of keeping track of their licence numbers would have been considerable. The concept of proportional depreciation permits a simpler procedure. We developed a concept of 'preferred output' - the amount produced if each part of the capital stock

is employed using the factor proportions governing investment decisions at the time that part was acquired. There will be separate values of 'preferred output' for each type of capital, since the two types have different desired capital/output ratios and different depreciation rates. To find the output preferred for each vintage of capital goods, it is necessary to associate each quarter's investment with some desired capital/output ratio. This we have done by linking IME with J3L(KMEY) and INRC with J5L(KNRY). The lag in each case is approximately j/2. Actually, investment in each quarter comprises expenditures started in a number of previous quarters. Given fairly smooth movements in KMEY and KNRY, our simplification does not do violence to reality.

The values for preferred output are then obtained by accumulating increments and continually writing down the total by the relevant depreciation rates. Thus for IME we have:

$$UGPPAMP = .95\ J1L(UGPPAMP) + IME/J3L(KMEY) \qquad (3.11)$$

and for INRC we have:

$$UGPPANP = .99\ J1L(UGPPANP) + INRC/J5L(KNRY) \qquad (3.12)$$

Base values for UGPPAMP and UGPPANP are derived by dividing KME and KNRC in 4Q55 by the corresponding values of the desired capital/output ratios derived from the RDX1 trend-through-troughs procedure. (See [18] page 26.)

If there is a gap between desired output and UGPPAMP or UGPPANP, the flexible accelerator comes into play. The accelerator applies independently for IME and INRC. At this point the question of an appropriate time horizon gets a little tricky. We want to measure desired output j periods in the future, yet UGPPAMP and UGPPANP measure preferred output using the current capital stock. As we have sworn off the full-blown forward-looking model with its 2j equations, another simplification is necessary. We simplify here by assuming that knowledge of projects already underway and coming to fruition within the next j periods will lead firms to respond less than fully to an indicated gap between expected UGPPA and current preferred output. The output gap is defined as desired output minus UGPPAMP in the case of IME and as desired output minus UGPPANP in the case of INRC. These two gaps are converted into capital stock gaps when multiplied by KMEY and KNRY, and into synthetic investment series by application of the appropriate distributed lags for expenditures.

An alternative procedure to this vintage approach would be simply to apply the RDX1 model directly, thus implying that capital goods can be equally well employed in any factor proportions, so that there is full ex post as well as ex ante substitutability. This alternative was tested and found to be inferior to the vintage approach in the investment equations. Our attempts to mix the two approaches also produced results favouring the pure vintage approach in the investment equations, although the nonvintage version was more successful in the employment equations.

C Business Inventory Investment

One major difficulty with the usual models of inventory accumulation (e.g. as discussed in [17], pp.6-15) is that the buffer-stock role for inventories is not properly identified. The buffer-stock variable is defined as the difference between expected sales and actual sales, with a coefficient that should lie between zero and 1, depending on how easily production levels can be adjusted. Aside from the problem of identifying the coefficient when sales expectations are themselves determined by current and lagged sales, the usual models are based on the assumption that production can be fully altered from quarter to quarter. In view of the long lags that characterize the demands for labour and capital, we prefer not to use expected sales as a proxy for production plans.

The explicit production function developed to integrate our fixed investment and employment equations gives rise quite naturally to a more precise definition of planned output. In our first experiments with the fixed investment equations we used gross real private output (UGPP) as the basis for expectations about desired future output. A search over plausible values for production function parameters produced a 'best fit' (in terms of the derived investment equations, with dependent variables summed to provide calculated values for total business fixed investment) having parameter values a = .205, b = .145, c = .65. The implied labour share is close to that indicated by the statistics on aggregate income distribution. Our assumption of Harrod-neutral (labour-augmenting) technical progress, when combined with the

labour requirements defined by the production function and the actual trend in total man-hours worked in mining and manufacturing, determines the average rate of increase in labour efficiency. The rate of technical progress enables us to construct a time series for the actual labour inputs in terms of efficiency units. When this labour input is used in the production function along with the beginning-of-quarter stock of capital goods, the result is a synthetic output series called UGPPS.

We interpret UGPPS as a short-run aggregate supply variable. It represents what would be produced in the current quarter if the factor inputs currently employed are used at trend levels of productivity. The inducement for buffer-stock accumulation of inventories is defined by the excess of UGPPS over all non-inventory categories of final demand, i.e. UGPPS-(UGPP-IIB). When the normal output of currently employed factors of production exceeds current final demand, firms may underutilize the employed factors or allow the excess production to accumulate in inventories, or do both. The coefficient on our buffer-stock variable will indicate the average relative importance of these two kinds of adjustment.

Although the innovations proposed above seem justified on theoretical grounds, they proved to be empirically essential in our attempts to estimate a reasonable inventory equation using the revised national accounts data. The new quarterly series for the change in business inventories has considerably more variance than the old series and is not adequately explained by the RDX1 equation. The RDX1 equation, based on sales, the change in

sales, the lagged stock of inventories, an unemployment index, and improved by the addition of a four-quarter moving average of the real supply price of capital (RHOR) had an RB2 of .74 when fitted for the period 1Q56-4Q68 using the old national accounts data. Using the revised data, the RB2 fell to .68 and all the coefficients, except that on the unemployment index, became insignificant. The addition of the buffer-stock variable defined above increased the RB2 to .86 and greatly strengthened the sales and lagged capital stock variables.

The passive inventory accumulation variable coupled with some revisions of the sales variables cause the unemployment index to drop out of the equation altogether. In RDX1 we thought of the employment index as a variable reflecting the degree of business confidence, but our present work suggests that this index is more likely to be a misspecified measure of aggregate supply since it is partly a measure of current employment relative to a moving average.

The RDX1 sales variable excluded expenditure on consumer services and government wages, and included total exports less total imports. This sales concept was referred to as 'purged' GNE. In RDX2, the purging process is carried further by defining the relevant export and import series as net of services. Furthermore, we thought that investment expenditure ought to be treated separately from consumer expenditure since no retail inventories are associated with the former, and substantially different sorts of goods are involved. We were also uneasy about the reasoning underlying the subtraction of imports from the sales variable. In order to ensure that an increase in final

sales, offset by an increase in imports, is irrelevant to inventory holders, one must assume that stocks of imported goods are held constant while these changes in sales occur. We now think it more reasonable to assume that final expenditure in Canada on at least some types of imported goods will lead to temporary reductions of inventories of such goods. In short, domestic inventories may play a buffer-stock role with respect to imported goods. Thus it seems desirable to treat imports, investment, and consumption separately in the flexible accelerator component of the inventory equation. Although it might also be desirable to split up the buffer-stock variable, our aggregate supply variable permits no such disaggregation. We proceed now to consider the chosen equation.

IIB Change in nonfarm business inventories (Equation 3.3)

In estimating this equation, we generalize the basis for expected sales to include data from the current quarter and seven lagged quarters. The implicit expectations weights are constrained to lie on a second degree polynomial passing through zero at quarter t-8. Since the appearance of the lagged inventory stock in the equation implies a response lag common to all components of expected sales, the difference in Almon weights among the various expenditure categories must reflect any differences in response pattern as well as in definition of sales expectations.

The equation contains: a constant term; three constrained quarterly variables, each multiplied by the lagged inventory stock; the lagged stock itself; the buffer-stock variable [UGPPS-

(UGPP-IIB)]; and lag distributions on three expenditure series. The largest expenditure series is the sum of consumer expenditure on goods, exports of goods, and government current nonwage expenditure. The weights are fairly evenly distributed, with a modest peak three quarters back. Interpreted in conjunction with the coefficient on the lagged inventory stock, the weights imply a marginal stock/sales ratio of 1.54, or .385 if annual sales are used for the denominator of the ratio. The sum of the coefficients on imports of goods is negative and about equal in size to the positive sum on the consumption variable. However, the equation fits noticeably better than when imports are simply subtracted from the sales variable, because the time pattern of response is quite different. The coefficients on imports have weights that are first positive and then negative. These coefficients suggest that inventories play an additional buffer-stock role with respect to imported goods. Any increase in imports of goods leads to some immediate increase in inventories, although in the longer term a higher import content of final demand reduces desired inventories in relation to final demand because of the implied decrease in domestic production.

The weights on investment, the third of our sales components, are positive first and then negative, suggesting extrapolative expectations. The pattern is similar to that for imports. The sum of weights is only one-fourth as great as that on consumption expenditure. It seems reasonable that the equilibrium ratio of inventory stock to fixed investment should be low, in the light of the high direct import content of machinery and equipment investment, the high direct labour

content of construction, and the absence of retail inventories of investment goods.

The coefficient on the buffer-stock variable is .461, indicating that, in addition to intended inventory investment derived from the expected sales variables, almost half of any difference between UGPPS and non-inventory final demand will be absorbed in, or taken from, inventory stocks. Any remaining difference between UGPPS and final demand (taking into account both the flexible accelerator and the buffer components of inventory accumulation) is accounted for by short-term changes in productivity. The buffer-stock variable is the strongest in the equation, with a t-value of over 9. The equation as a whole provides a considerably better fit than any of our earlier models. The standard error of estimate is $66 million, and the RB2 is almost .89.

The results of the inventory equation suggest a way of removing some of the unintended portion of aggregate output. We hope thereby to approach a measure of aggregate demand less affected than is UGPP by short-term supply constraints. Our new demand variable is called UGPPA, and is equal to UGPP minus .4610[UGPPS-89.9-(UGPP-IIB)]. (The constant 89.9 is the mean of the adjustment term and is included in the expression so that UGPP and UGPPA will have the same mean values.) This was not the only alternative open to us, for we could have defined the unintended component of inventory accumulation as .4610[UGPPS-(UGPP-IIB+intended inventory investment)], where intended inventory investment is defined by the coefficients on the sales variables and the lagged inventory stock. This alternative

procedure gave us values for UGPPA that performed less well in the fixed investment equations, so we continue to use the simpler definition. We turn now to the fixed investment equations based on UGPPA.

D Business Fixed Investment Equations

As we indicated in section B, both vintage and nonvintage versions of the derived investment equations were fitted to quarterly data for the period 1Q59-4Q68. In addition to running the two versions as alternative equations, we estimated equations containing both vintage and nonvintage synthetic investment series as independent variables. Only the vintage variables were significant in the equations where both appeared, so the vintage version is presently employed in RDX2.

Equations 3.1 and 3.2 show the results for IME and INRC. Both equations are estimated net of a constant proportion of the lagged capital stock. Our earlier experiments indicated that gross investment equations, fitted with these same fractions of the lagged capital stock as independent variables, produced coefficients of 1.0 on these 'depreciation' variables. (See [18] pp.18-30, and pp. 58-60.)

Our initial estimates of the IME and INRC equations contained only seasonal variables and the synthetic investment series. Very low Durbin-Watson statistics in the initial estimation of the net investment equations indicated that important systematic variables either had been misspecified or

left out. This should be no surprise to anyone, for our aggregate production function with fixed coefficients is being used to represent a wide variety of processes. Some of these processes were in use for only part of the data period, and in general the relative importance of the various processes shifts over time.

As well, in our synthetic investment series we take no account of variations in the timing of investment outlays in response to changes in financial conditions, supply constraints, or other factors. We therefore tested a number of supplementary timing variables, and the preferred results are embodied in equations 3.1 and 3.2.

The IME and INRC equations each have three variables influencing the speed with which a gap between actual and desired capital stock is filled. Four separate variables are involved, and each is measured as a ratio to a moving average. The resulting indexes measure the inflow of foreign direct investment funds, cash flow generated by Canadian corporations, bank loans to business, and the rate of interest on long-term bonds. The direct investment and cash flow variables enter both equations, and the loans index and the interest rate index influence IME and INRC, respectively. All the timing variables enter with polynomial distributed lags. Their net effect is to improve substantially the goodness of the fit and the residual properties of the equations. The resulting IME equation has no first-order autocorrelation of errors, and has a standard error of $44.7 million. The INRC equation fits even more closely, with a standard error of $20.8 million, but retains fairly high

autocorrelation of residuals. Re-estimation of both equations using the Hildreth-Lu procedure leaves the structure of the IME equation untouched, but reduces moderately the coefficients on the timing variables in the INRC equation. We hope that our timing variables reflect genuine causal forces, and are not just mopping up a complicated pattern of autocorrelated errors traceable to some other source.

The low coefficients on the gap variables in the two investment equations suggest that either output or price and cost expectations, or both, are more regressive than they are assumed to be in our model. Alternatively, we might argue that the low coefficients are due to errors of measurement in the variables defining KMEY, KNRY, and UGPPA, or that certain supply constraints in the investment goods industries are not represented by movements in the national accounts price deflators. This feature of our results is not new to our present framework, however, for it characterized both the RDX1 equations [18] and the "forward-looking" model [29]. Even though improvements are yet to be made in the present equations, we regard them as being structurally and empirically superior to the RDX1 equations.

E Aggregate Supply and Demand and So On

In this section we catalogue the various concepts we have derived from UGPP. Some of them have been explained earlier in the chapter; others (UGPPD and the capacity utilization

variables) are introduced here. The preferred output series, UGPPAMP and UGPPANP, are specific to the investment equations, and need not be re-explained now. We start with a description of our real output variables.

UGPP Gross private business product, excluding agriculture and noncommercial services, 1961 dollars (Equation 3.13)

Our object in defining this variable was to approximate some measure of total output produced by the business sector. In RDX1 we made extensive use of a total private sector domestic expenditure variable (called YGPK), to which we added government nonwage expenditure to obtain an approximation of private sector output. We also made use of a series (called Y) for real domestic product ex agriculture. As a way of measuring the output of the nonagricultural business sector, the combination of YGPK and government nonwage expenditure is inadequate because it implicitly includes farm output and value added by noncommercial institutions (mainly schools, hospitals, and universities). Real domestic product ex agriculture has the disadvantage of including the value added both by the government sector and by noncommercial institutions. In RDX2 we attempt to overcome this difficulty by constructing a private output variable especially for our purposes. The current-dollar version, YGPP, is obtained (as shown in equation 8.5) by subtracting from YGNE all wages, salaries, and supplementary allowances paid by governments and noncommercial institutions, farm wages, and accrued farm income. We thereby assume that wage payments represent the value added by governments and noncommercial institutions, and that accrued farm

income plus farm wages represent value added in the agricultural sector. The corresponding constant-dollar output variable, UGPP, is obtained by subtracting 1961-dollar equivalents of government and institutional wage payments, and farm income, from constant-dollar gross national expenditure (YGNE/PGNE). These constant-dollar wage series are employment series multiplied by the relevant 1961 wage rates. Details of the calculations for PGPP are shown in equation 7.22, so that equation 3.13 defines UGPP as UGPP = YGPP/PGPP.

Our production function analysis treats UGPP as the output from KME, KNRC, and NMMOB. However, this is not strictly correct, for UGPP includes the value added by the construction industry, and, although KME and KNRC are the corresponding total capital stocks, NMMOB does not include construction industry employment (NC). In some of our experiments we adjusted for this discrepancy either by using NMMOB plus NC as the employment input or by subtracting construction wages, in constant-dollar terms, from UGPP. These further complications did not make any significant difference, so we continue to use NMMOB as the employment input to the production function for UGPP, and to explain employment in construction separately. In 1968, the average number employed in construction was less than 10% as large as in mining, manufacturing, and other business.

UGPPA UGPP adjusted to remove unintended inventory changes (Equation 3.14)

This variable provides a measure of aggregate demand that differs from actual output (UGPP) by the subtraction of any

increase in inventories arising from their buffer-stock role, i.e. UGPPA is equal to UGPP less the buffer-stock variable (minus its sample mean) multiplied by its estimated coefficient from the inventory equation. In using UGPPA rather than UGPP as the basis for expectations about desired future output, we are supposing that any increase in output resulting in unintended inventory accumulation does not give rise to greater desired levels of capital stock and employment.

We cumulated the difference between UGPP and UGPPA (or rather took a twelve-quarter moving sum to avoid having one more equation) as a measure of excess or deficient inventories. This measure was tried, in preference to the stock/sales ratio of RDX1, as an independent variable in the price equations.

UGPPD Desired output based on production function with actual capital stock, average employment rate, and trended weekly hours (Equation 3.15)

This variable, like UGPPS, is a measure of output forthcoming at average productivity levels. UGPPD is what the assumed production function would yield if the capital stock and the labour force were utilized to an average extent. The production function inputs are the actual (beginning-of-quarter) stocks of KME and KNRC, the employment series NMMOB adjusted for untypical rates of unemployment, and 'normal' hours. 'Normal' hours are obtained from a regression of average weekly hours worked in mining and manufacturing (HAWMM) on a constant and a time trend. The adjusted employment series is obtained by multiplying the actual level of NMMOB by (1+NL/NE-1.05179), where

1.05179 is the average value of the ratio of the total labour force (NL) to the employed labour force (NE). UGPPD does not represent full capacity output, for it assumes an average level of factor utilization, and hence has the same mean value as actual output UGPP. If, on average, the providers of labour and capital services would have preferred a higher level of utilization, then UGPPD is less than desired output by the proportion that the desired degree of factor utilization exceeds the historical average.

Since UGPPA is our concept of aggregate demand, and UGPPD our longer-term measure of aggregate supply, the ratio of one to the other gives some measure of the extent to which aggregate domestic supply and demand are out of balance. This ratio is an important determinant of prices and foreign trade - two of the main mechanisms that restore balance between domestic supply and demand.

UGPPS Aggregate supply based on production function with actual factor inputs (Equation 3.16)

This variable, already described in section B, indicates the level of output forthcoming, at average productivity levels, from the beginning-of-quarter capital stock combined with current labour inputs. In the presence of an exogenous change in aggregate demand, UGPPS responds faster and more strongly than UGPPD, because changes in employment and average weekly hours are induced by the change in demand. Actual output (UGPP) responds even more than UGPPS, owing to short-term changes in productivity. This result is, quite naturally, a consequence of

lags in the processes of altering capital stocks and the level of employment, and also a consequence of limitations in the extent to which it is possible or desirable to vary average weekly hours. Actual output itself does not respond fully to a change in aggregate demand (as measured by UGPPA) because of the buffer role played by the stock of business inventories.

Thus if we arrange our UGPP concepts in a row with UGPPA (aggregate demand) at one end and UGPPD (desired output) at the other, then UGPP (actual output) and UGPPS (the current supply variable) are in the middle, with UGPP adjacent to UGPPA and UGPPS beside UGPPD. This plethora of UGPP's seems confusing at first, but we have gained confidence in these concepts as each version appears to serve faithfully its allotted role.

CHAPTER 4

FOREIGN TRADE

SECTOR 4

A An Overview of the Sector

In this chapter we describe the twenty-two behavioural and nine technical relationships comprising the foreign trade sector of RDX2. Section B of the chapter contains a description of the nine constant-dollar equations for trade in goods - six equations for imports and three for exports. Section C is concerned with the five current-dollar equations for capital service payments and receipts, all of which provide links between the capital account and the current account of the balance of payments. In section D we discuss the eight current-dollar equations relating to payments and receipts for travel, and for freight and shipping.

The construction of a fairly large number of trade equations was dictated by our desire to treat flows between Canada and the United States separately from those between Canada and other countries. This split is necessary to permit the linkage of RDX2 with the MPS quarterly model of the U.S. economy. A separate report on the linkage project [36] contains some supplementary discussion of the fourteen behavioural equations for trade flows between Canada and the United States. The greater disaggregation of the Canadian-U.S. flows was also prompted by their relatively

large size and by the availability of suitable explanatory variables from the U.S. model. The heterogeneity of Canada's other major trading partners reduced the potential gains available from disaggregation by commodity for this group of countries.

Another general feature of our trade equations is that the equations for goods are estimated in constant dollars, whereas those for services are in current dollars. The treatment of flows of goods in constant dollars is consistent with our expenditure equations elsewhere in the model. Some of the service flows, such as interest and dividend payments, do not have any 'real' equivalents, so that no conceptually adequate price deflators can be obtained. For travel expenditure, and for freight and shipping, the available price data were not good enough to encourage us to develop and explain constant-dollar series. In order to derive constant-dollar measures of total imports of goods and services (M, equation 4.27), and total exports of goods and services (X, equation 4.28), we make use of exogenous price indices for imports and exports of total services.

The eight technical relationships in this sector are all merely totals or balances of the constant- or current-dollar measures of trade flows. Current-dollar trade totals are constructed separately for flows between Canada and the United States (M$12 and X$12, equations 4.23 and 4.24), and between Canada and other countries (M$13 and X$13, equations 4.25 and 4.26).

To complete this brief overview of the sector, and to preview some of the results, we have constructed Table 4.1 in which we list the behavioural equations of Sector 4, present estimates of exchange rate elasticities, and give some idea of the size of the various flows. The relative magnitudes of each of the items are given by the 1968 average quarterly flows in millions of current dollars. The table also includes some total items (MG$, M$, XG$, X$, XBAL$) with associated flows that may be larger than the sum of their listed components since the table does not contain the exogenous components of the totals. The unlisted exogenous components are shown explicitly in equations 4.23 to 4.31.

The elasticities in Table 4.1 are calculated with respect to changes in the price of foreign exchange (PFX). In order to calculate elasticities for the current-dollar flow of goods, we had to calculate first the elasticity of each trade price with respect to PFX, and then calculate the direct and indirect (acting through the trade price) effects of PFX on the constant-dollar flow. Some of the import prices have unit elasticity with respect to the exchange rate because the equations were estimated with the dependent variable defined as the trade price divided by PFX as described in Chapter 7. One import price (PMNTE13) is exogenous, and we have shown it to have an elasticity of 1.0 with respect to PFX because we run our revaluation simulations using that assumption. For simulations with the exchange rate moving between its 1962-1970 fixed support points, the only import prices that vary are the four covering imports of goods (excluding motor vehicles and parts) from the United States. The

TABLE 4.1 EQUILIBRIUM EXCHANGE RATE ELASTICITIES

Canadian Imports	Exchange Rate Elasticities of Constant-Dollar Flow	Trade Price	Current-Dollar Flow	Average Quarterly Flow in 1968	1968 Flow Effect of 1% Drop in PFX
MFB12	-1.15	1.0	-0.15	113.6	0.17
MEF12	-0.30	1.0	0.70	72.5	- 0.50
MCM12	0	1.0	1.0	107.8	- 1.08
MMF12	-0.65	0.84	0.19	1069.4	- 2.03
MMV12	0	0	0	687.2	0
MNTE13	-0.82	1.0	0.18	741.4	- 1.33
MG, MG$	-0.54		0.19		- 4.77
MINT$12			0	125.0	0
MDIV$12			0	143.5	0
MTR$12			-1.59	177.5	2.82
MFS$12			-0.10	140.3	0.14
MID$13			0	46.0	0
MTR$13			0.67	74.5	- 0.50
MFS$13			0.80	92.5	- 0.74
M$			0.07	4322.8	- 3.05
Canadian Exports					
XMV12	0	0	0	602.7	
XNMV12	0.74	0.35	1.09	1628.5	-17.75
XNW13	0.21	0.27	0.48	886.3	- 4.25
XG, XG$	0.39		0.62		-22.00
XID$12			0	57.8	0
XTR$12			1.77	222.8	- 3.94
XFS$12			0.86	116.8	- 1.00
XID$13			0	30.5	0
XTR$13			0	222.8	0
XFS$13			0.34	106.0	- 0.36
X$			0.60	4520.8	-27.30
XBAL$					-24.25

Note:
The elasticities are calculated using the sample means of the variables as they appear in the equations. The 1968 average flows are in current dollars. $ denotes a current-dollar variable. Trade with the United States is denoted by 2, with other countries by 3. FB is food and beverages, EF is energy fuels, CM is crude materials, MF is manufactures, MV is motor vehicles, NTE is everything except transportation equipment, G is total goods, INT is interest, DIV is dividends, TR is travel, FS is freight and shipping, ID is interest and dividends, NMV excludes motor vehicles, and NW excludes wheat. XBAL$ is total current-dollar exports minus imports.

motor vehicle trade prices are exogenous, awaiting more precise modelling of the shifting structure of North American auto production. All the main export prices are influenced by the exchange rate as reported in Chapter 7, reflecting the assumption that prices for many Canadian exports are affected by world market prices as well as by domestic conditions.

As a final note, the elasticities for trade totals are calculated on the assumption that the exogenous trade flows and the prices of service imports and exports are unaffected by exchange rate movements. The chief justifications for this treatment are that the exogenous items (such as imports of aircraft) are lumpy, are not clearly influenced by relative prices, and constitute a fairly small part of total trade.

The reader who has grappled with Table 4.1 will by now either have closed the book or be ready to consider the equations themselves.

B Merchandise Trade

1 Imports of Goods from the United States (Equations 4.1-4.5)

There are five equations for imports from the United States. The commodity disaggregation is the same as that agreed upon for Project LINK, except that we treat motor vehicles and parts separately, and leave exogenous other transportation equipment and miscellaneous imports (SITC 9). The Project LINK categories are food and beverages (SITC 0,1), energy fuels (SITC 3), crude

materials (SITC 2,4), and manufactures (SITC 5-9). This split was chosen with an eye to using linked national models to explain world trade flows (the concepts and equations underlying the project are described in various chapters of [3]); thus it is not surprising to find from Table 4.1 that most Canadian imports lie in the manufactures category.

In explaining trade flows between Canada and the United States, we were aware that each equation for Canadian imports would also be an equation for U.S. exports in our linked simulations. We therefore investigated various U.S. supply constraints, in addition to U.S. domestic prices, as factors explaining Canadian imports.

The central driving variable in each of our imports of goods equations is a synthetic measure of import requirements. In the motor vehicles equation we simply use consumer expenditure on motor vehicles. For crude materials we use the RDX2 measure of business output (UGPP). For the other equations the import requirements variable is a weighted average of up to six final demand categories. The a priori weights used in each case are based on input-output information (from the 1961 Dominion Bureau of Statistics (DBS) input-output table [7], the latest available) about the amount of different types of imports represented in each final demand category. For each import category the weights on the various components of final demand are scaled so that they sum to unity. The weights are strikingly different in the various equations. For example, in equation 4.1 for imports of food and beverages, 83% of the weight is attached to consumer expenditure on non-durables and semi-durables (CNDSD), and no

weight is given to fixed investment. By contrast, in equation 4.4 for imports of manufactures, the implied weights attached to CNDSD and to business fixed investment in machinery and equipment are about .07 and .70, respectively.

Relative price variables enter the import equations either as separate variables, as in equation 4.1 for food and beverages, or multiplied by the import requirements variable, as in equation 4.2 for energy fuels and equation 4.4 for manufactures. In equations 4.3 and 4.5 for crude materials and for motor vehicles the relative price variables did not show a significant influence in either of the forms tested. The definition of a relative price variable depends on the type of commodity involved. For example, imports of food and beverages are assumed to flow directly into consumption so that the relative price is the relevant import price divided by the Consumer Price Index. Imports of energy fuels, chiefly industrial coal and crude oil, enter the production process at an early stage, and thus the price of business product is divided by the import price to define the relative price. A similar treatment is used in the equation for imports of manufactures, although here there are important amounts of consumption goods as well as investment goods involved. In the latter two cases, the relative price is defined with the domestic price in the numerator because the price variable is multiplied by the demand variable.

The main reason for including capacity utilization rates in both Canada and the United States is that the measured trade prices do not reflect market-clearing prices. This may happen either because the reported prices do not reflect fully the

variance in actual prices, or because firms prefer to vary the length of order books, quantity discounts, or other conditions of supply rather than make frequent price adjustments. Under this argument, there is little reason for the relationship between the implicit market-clearing price and the quoted price to be different for Canadian than for U.S. prices. Thus one might expect to find, as in equation 4.3 for crude materials, that Canadian and U.S. capacity utilization rates have a symmetric impact on the northbound flow of goods. In that equation, in fact, the ratio of Canadian to U.S. capacity utilization replaces entirely the relative price variable.

In equation 4.4 for imports of manufactures the U.S. capacity utilization rate did not perform its expected role, so the Canadian utilization rate appears on its own.

In addition to the general influences described above, there are a few special purpose variables in these import equations designed to reflect abnormal influences in some commodity groups. The most important of these variables is QAUTO, representing the increasing degree of integration of North American auto production after the Canada-United States Automotive Agreement took effect in 1965. This variable appears in the equations for both northbound and southbound flows of motor vehicles and parts, depicting how both flows have been increasing in size relative to motor vehicle production and use in the two countries.

2 Imports of goods from other countries (Equation 4.6)

We have a single equation for imports of goods from countries other than the United States. The dependent variable is total imports of goods from these countries, excluding a small exogenous series for transportation equipment and for unclassified commodity transactions (SITC 9). The main causal variable in the equation is a weighted combination of final demand categories times the price of business product divided by the import price.

3 Exports of goods to the United States (Equations 4.7-4.8)

In equation 4.8 we explain exports of goods other than uranium, aircraft, and motor vehicles. The main independent variables are U.S. capacity utilization, U.S. gross national expenditure multiplied by the rate of capacity utilization, and a relative price term. The numerator of the relative price term is the Canadian dollar equivalent of U.S. domestic investment prices and the denominator is the price of this category of Canadian exports. All these variables enter the equation with polynomial distributed lags extending as long as sixteen quarters for the U.S. expenditure variable. Canadian capacity utilization was not found to have a significant role in this equation.

Exports of motor vehicles (equation 4.7) are determined by the sum of Canadian plus U.S. expenditure on consumer durables, all multiplied by QAUTO. We should have preferred to use

consumer expenditure on motor vehicles rather than total expenditure on durables, but such a split is not made for the U.S. within the MPS model. Exports of motor vehicles and parts to the United States were relatively minor prior to the 1965 auto pact, and our estimation period starts only in 1Q63.

4 Exports of goods to other countries (Equation 4.9)

This equation is estimated in log-linear form. Thus variables that were multiplicatively related in our other equations are separate terms in this equation. The main variables are total world trade (excluding U.S. and Canadian imports), a relative price variable, and Canadian capacity utilization. There is also a separate world trade variable spanning the flexible exchange rate period, indicating that the elasticity of Canadian exports with respect to the volume of world trade was marginally higher during the flexible exchange rate period. The elasticity of exports with respect to relative prices and capacity utilization is about -.75 in both cases, compared to 1.07 for the volume of world trade. The relative price variable is the Canadian export price divided by the Canadian dollar equivalent of the price index for world exports of goods.

C Capital Service Payments and Receipts

We have adopted the point of view that a model of an open economy cannot be complete unless it has structurally appropriate equations not only for capital flows but also for the consequential international flows of interest and dividends. Otherwise, one cannot assess correctly the net balance of payments effects of monetary and fiscal policies. In that connection it has been argued (e.g. [54]) that the alleged comparative advantage of using monetary policy to attain a balance of payments target may not exist if account is taken of the higher service imports involved - interest payments on foreign-held debt. These are, of course, caused by the higher domestic interest rates designed to induce the inflows of capital needed to shore up a temporarily weak balance of payments. The resolution of this issue depends on the answers to a number of empirical questions. For example, when there is a sustained interest rate change, how rapidly will the new rates come into effect on the total stock of international indebtedness? A precise answer to this question requires vintage accounting for international indebtedness and direct information or assumptions about its maturity structure. The scantiness of available data on trade in outstanding securities denies us the opportunity of developing such accurate specifications, but we think we have developed much better equations than those previously available. Even in macro-models designed with the balance of payments in mind, the international interest and dividend equations, if they exist at all, are driven by proxy variables for debt and rates of return. Therefore these equations cannot be used to undertake realistic policy simulations.

Within the confines set by the data and the degree of aggregation in our explanation of capital flows, we have developed a number of disaggregated indebtedness series and weighted average interest rates. In constructing equations for interest payments on foreign-held long-term debt, we accumulate the appropriate indebtedness series (based on data for new issues and retirements of bonds, and trade in outstanding bonds) to which we apply weighted averages of past long-term interest rates (using weights that depend on the volume of gross new issues). In explaining dividend payments, our basic intent is to isolate the fraction of corporate profits that accrues to foreign shareholders and then to develop equations based on some theory of dividend payments.

The capital service payments equations are more detailed and disaggregated than the receipts equations. This is so because our accounting for Canadian liabilities is more precise, and because Canadian capital service payments are much larger than the corresponding receipts. We describe the payments equations first.

1 Interest and dividend payments to foreign residents (Equations 4.16-4.17 and equation 4.20)

There are separate equations for interest and dividend payments to U.S. residents, and a combined equation for payments to other foreign residents.

Equation 4.16 for interest payments to the United States (MINT$12) is based on a synthetic interest payments series

entering the equation by itself and also multiplied by the three constrained quarterly variables. The dependent variable is a quarterly flow, and the synthetic series an annual equivalent. The estimated coefficient of .259 on the average quarter is reassuringly close to, although significantly above, its theoretically correct value of .250.

The synthetic interest payments series is the product of a debt series (LCB12+LGB12) accumulated from balance of payments statistics, and a weighted average of past values of Canadian and U.S. long-term interest rates. There are several stages in the endogenous weighting of these interest rates. A weighted U.S. rate is constructed by multiplying the U.S. rate in the current and preceding nineteen quarters by the corresponding quarterly total of the flow of new Canadian bond issues sold in the United States (plus sales of outstanding Canadian bonds in the United States). This product in each quarter is then divided by the exchange rate for that quarter, and the resulting values are summed over twenty quarters, divided by the twenty-quarter sum of the relevant capital inflows, and then multiplied by PFX. The exchange rate adjustment requires explanation. The U.S. synthetic rate applies to the U.S.-pay portion of Canadian bonds held by U.S. residents. If PFX at any time is higher than the exchange rate when a bond was originally issued, the Canadian dollar equivalent of U.S.-pay coupons is proportionately increased. Thus the synthetic U.S. interest rate series contains a component equal to the ratio of current PFX to a twenty-quarter average of past values of PFX, where the weights on past values

depend on the flow of bonds sold to U.S. residents in each quarter.

The weighted average Canadian interest rate is similar but simpler to calculate because no adjustment is required for exchange rate changes. All that matters is the Canadian dollar value of bonds at the time of purchase and the yields then prevailing. Our series may be biased if there is a systematic difference between interest rates on new issues and RL, the average yield on Government of Canada bonds of ten years and over to maturity.

The weighted U.S. and Canadian interest rates are combined with the relative weights .757/.243, reflecting an estimate of the split between U.S.-pay and Canadian-pay issues among the Canadian corporate and government bonds held by U.S. residents.

We think that equation 4.16 captures the main determinants of the flow of interest payments to the United States and will allow us to simulate some of the important current account consequences of monetary policy. The equation fits closely, with an RB2 of .972, a standard error of $5.12 million, and a coefficient of variation of 7.25%. The mean value of the flow in 1968 was $125 million per quarter.

Equation 4.17 for dividend payments to the United States by Canadian corporations (MDIV$12) is based on the cash flow accruing to the credit of U.S. shareholders rather than on total dividend payments. We allow the structure and timing of dividends paid to foreign shareholders to differ from those of dividends paid to Canadian shareholders, since U.S. shareholders often have different interests than Canadian shareholders.

Because many corporations are controlled by U.S. shareholders, we expect to find these different circumstances reflected in different dividend payout policies.

The main independent variables are the four-quarter moving sum of corporate cash flow accruing to U.S. shareholders, and the dependent variable lagged four quarters. An increase in cash flow evokes an apparent response that is slightly slower and smaller than the corresponding response in the case of dividends paid to Canadian shareholders. (See equation 8.2.) The equilibrium payout ratio to U.S. shareholders is 20.2% of cash flow, with three-fourths of the change taking place in the first year. A payout of 20.2% of after-tax profits plus book depreciation is equivalent to 37% of after-tax profits. The accuracy of these results, as indicators of management policy, depends on the validity of LDIRV12 and LPCV12, our measures of the values of the claims of U.S. direct and portfolio investors. The accounting underlying these series is described in section D of Chapter 10.

The RB2 of equation 4.17 is .853, with a standard error of \$16.3 million - about 14% of the average value of the quarterly flow over the sample period.

Interest and dividend payments to other countries (MID\$13) are explained together in equation 4.20. A simple treatment is excused by the fairly small size of the series. MID\$13 has a sample mean of \$35 million, less than one-sixth as large as the average value of interest and dividends paid to the United States. The main independent variable is the product of the book value of indebtedness of business (LDIPRV13) and governments

(LGB13) to other countries and a weighted average of a constant and a twenty-quarter simple moving average of the Canadian long-term interest rate (RL). A simple moving average of RL is used because we do not explain corporate debt and equity flows to other countries separately in RDX2. A weight of 24.1% is attached to the interest rate series because interest payments make up that portion of MID$13. The constant .013 used in the rate of return implies that dividends are a constant fraction (excluding seasonal fluctuations) of the book value of direct and portfolio investment including retained earnings. Attempts to make direct use of corporate cash flow in explaining the dividend component of MID$13 were not successful. The equation has an RB2 of only .596, but the standard error is just $5.4 million, and the equation has enough structure to be worthwhile.

2 Interest and dividend receipts from foreign countries (Equations 4.10 and 4.13)

Only aggregate book value figures are available for Canadian claims on U.S. residents and on residents of other foreign countries. We therefore have equations for aggregate interest and dividend receipts from the United States (XID$12, equation 4.10) and from other countries (XID$13, equation 4.13).

Equation 4.10 is estimated as a ratio of total U.S. interest and dividend payments. The main independent variable is the ratio of the indebtedness of the United States to Canada (A12) to the Canadian dollar equivalent of the sum of U.S. household wealth (VCN$2) and A12. This ratio enters the equation

multiplied by the four linear quarterly variables, Q1 to Q4. Although the fit is not good, the structure is reasonable.

We found equation 4.13 more difficult to handle because no suitable series exist for wealth and investment income in other countries in which Canada invests. Structurally, the equation is similar to that for MID$13, as the main independent variable is the book value of the indebtedness of other countries to Canada (A13) multiplied by a weighted average of a constant and a twenty-quarter moving average of the U.K. long-term interest rate (RLUK). The constant is equal to the average sample value of the moving-average interest rate, and the relative weights attached to the constant and to the interest rate series are .696/.304, corresponding to the relative amounts of dividends and interest in the total flow.

The equation is substantially improved by the addition of the variable QXDIV accounting for an extraordinary $60 million dividend payment from a U.K. subsidiary. QXDIV is 1.0 in 4Q64, and takes a significant coefficient of 54.6, so it is playing an appropriate role. The resulting equation has an RB2 of .759 and a standard error of $7.76 million, which is about 32% of the average size of XID$13 during the sample period. The main coefficient is .284; it would be .250 if interest and dividends were both paid on A13 according to a twenty-quarter moving average of RLUK.

Taken as a group, the interest and dividend payments and receipts equations provide significant links between the current account and the capital account of the balance of payments, and

will add considerable range to the simulation experiments that can usefully be undertaken using RDX2.

D Payments and Receipts for Other Services

1 Travel payments (Equations 4.18 and 4.21)

Both flows are estimated as ratios to the labour force population (NPOP), and depend principally on total current-dollar expenditure on consumer services and the exchange rate. The exchange rate elasticity of 'real' travel expenditure is high in the case of travel to the United States, about -2.59 if the U.S. prices paid by Canadian tourists are assumed to be unaffected by changes in the exchange rate. The corresponding price elasticity for travel to other countries is small, only -.33. Thus the exchange rate elasticity of the current-dollar flow for MTR$13 is .67, as shown in Table 4.1 and by the positive coefficient on PFX in equation 4.21. The travel equations also show a shift from U.S. travel to other foreign travel after 1958. This is attributed to increased duty-free allowances, but other explanations seem more plausible to us. There was also a drop in travel overseas for the duration of Expo67, an event that provided obvious domestic competition for travel abroad.

2 Travel Receipts (Equations 4.11 and 4.14)

Equation 4.11 for travel receipts from U.S. residents is estimated as a ratio to total U.S. population. The receipts depend chiefly on per capita U.S. consumption expenditure, the exchange rate, and Expo67. In Table 4.1 a current-dollar exchange rate elasticity of 1.77 is indicated, which is equivalent to an exchange rate elasticity of .77 for the constant-dollar flow. Thus we have some evidence that Canadians considering U.S. travel are more responsive to exchange rate variations than are U.S. residents considering travel to Canada.

The shortage of expenditure variables for the 'other countries' group led us to estimate equation 4.14 for travel receipts as a function of current-dollar world trade and Expo67. No exchange rate effect was found.

3 Freight and shipping payments (Equations 4.19 and 4.22)

The main determinant of freight and shipping payments to the United States is current-dollar imports of goods from the United States (MG$12). The equation also indicates that the sharp expansion of imports due to the auto pact has not led to a corresponding increase in freight and shipping payments. The exchange rate term, when considered in conjunction with the exchange rate elasticity of MG$12, indicates elasticities with respect to PFX of -.10 and -1.10 for the current- and constant-dollar flows, respectively.

Equation 4.22 for freight and shipping payments to other countries depends on current-dollar imports of goods from those countries, the exchange rate and the opening of the St. Lawrence

seaway. The latter event increased the ability of foreign carriers to transport imports closer to Canadian centres of population thus replacing transport previously provided by domestic carriers. The exchange rate elasticity shown in Table 4.1, calculated to take account of the exchange rate elasticity of current-dollar goods imports, indicates a positive elasticity for the current-dollar flow and a small negative elasticity for the constant-dollar flow. Thus an increase in the price of foreign exchange leads to a decrease in the volume of services purchased but to an increase in the number of Canadian dollars expended on services.

4 Freight and shipping receipts (Equations 4.12 and 4.15)

Equation 4.12 for receipts from the United States depends on current-dollar exports of goods to the United States, with a lesser effect from exports induced by the auto pact. Equation 4.15 for receipts from other countries depends on current-dollar exports of goods to those countries. Both equations show a hypothetical negative impact of the St. Lawrence seaway on Canadian freight and shipping receipts.

That completes our description of the trade equations of RDX2. We are not overly proud of them, and there is much further work to be done on this sector as better data become available for trade prices and constant-dollar flows. In the meantime the present equations do include many important factors in Canada's trading experience.

CHAPTER 5

BUSINESS EMPLOYMENT AND HOURS, LABOUR FORCE, AND POPULATION

SECTOR 5

A Introduction

In the business employment equations explained in this chapter we treat employment and hours in mining, manufacturing, and other business separately from employment and hours in construction. The former are explained in section B and the latter in section C. The equations for mining, manufacturing, and other business are part of the factor-demand model set out in Chapter 3; those for the construction industry are simpler relationships based primarily on the level of construction activity. Equations for employment by governments and schools are located in Sectors 12 and 13 and explained in Chapter 8.

The size of the labour force and relevant measures of the total population are largely determined by demographic relationships and only indirectly affected by the endogenous variables of RDX2, at least in the short run. Nevertheless, a number of economic factors affect labour force participation, and in our labour force equation (equation 5.5) we have tried to assess their net aggregate impact. This equation is described in section D. We have made the total population endogenous to RDX2 by including equations for immigration and emigration, both of

which depend significantly on economic conditions in Canada and other countries. These equations are described in section E. Our equations for population, labour force participation, and employment in business, government, and noncommercial institutions combine to define the level of unemployment (with the aid of exogenous variables for farm employment and some residual employment categories). Because the rate of unemployment plays an important role in our equations for wage rates and some government expenditures, we attach some value to accuracy in our employment, labour force, and population equations. In addition, the estimated employment series has important effects in equations for profits, prices, foreign trade, personal taxes, and so on.

B Employment and Hours in Mining, Manufacturing, and Other Business

1 The level of employment

There are a number of ways of deriving a demand for labour from the production function and relative prices. Which of these is most appropriate depends mainly on the costs and speed of altering labour inputs, a subject about which little is known. We assume that the costs of adjusting hours per week are less in the short run than are the costs of adjusting employment. This assumption is consistent with the RDX1 employment and hours equations. (See [34], pp.13-15.) We also assume that in the

longer run the desired level of average weekly hours is determined by slow-moving social and economic trends, while the level of employment is adjusted to meet the labour requirements indicated by desired output, production function elasticities, and factor prices. Thus several sorts of labour adjustment may be going on at the same time. Three sorts of possible adjustment are represented by the following variables.

(a) 'Short Gap'. This variable is found by taking the chosen production function, inserting the actual capital stock and the current value of the aggregate demand variable (UGPPA), and then calculating the implied labour input in terms of man-hours. The latter is divided by the linear trend value of average weekly hours in mining and manufacturing to get the labour input in terms of men of unchanged efficiency working a 'normal' number of hours per week. The difference in trend between this series and the actual level of employment in mining, manufacturing, and other business is removed and attributed to Harrod-neutral technical progress. The difference between the resulting series (NMMOBD) and the actual level of employment in the previous quarter can then be used as the main input to a standard adjustment equation for the number of employed workers.

(b) 'Long Gap'. This variable has the same general characteristics as the short-gap variable, except that the output variable is expected UGPPA and the capital inputs are obtained by multiplying KMEY and KNRY by expected UGPPA. The long-gap variable represents the gap between current employment and that required to produce expected output in conjunction with the

corresponding capital stocks chosen in the light of prevailing expectations about future factor prices.

(c) 'Vintage Gap'. This variable differs from the other labour gaps and is derived from the 'preferred output' concept. The vintage-gap variable represents the difference between current employment and that required to produce current output using labour according to the optimal output/labour ratios built into each vintage of the capital stock.

We estimated employment and hours equations based on the three labour-gap concepts described above. The vintage gap is the concept most compatible with the approach adopted in the investment equations, but the vintage gap does not perform as well as the short gap in the equation for the change in employment in mining, manufacturing, and other business. As an alternative specification, we tried adding the change in employment in construction to our dependent variable (since construction capital stock is in the capital stock series KME and KNRC, and since UGPP includes value added by the construction industry). Calculated employment in construction (obtained from an independent equation) was then subtracted from the calculated total in order to get calculated NMMOB. This method was inferior to that used in equation 5.1 determining NMMOB directly. Equation 5.1 is quite successful, and the implied trend rate of increase in labour efficiency indicated by the short gap is not unreasonable. The labour-efficiency variable (ELEFF) grows by .68% per quarter, or 2.75% per year. The final equation contains only the short gap, NMMOBD-J1L(NMMOB), since neither of the other measures of labour demand add any explanatory power. This

equation contains as well a set of constrained seasonals multiplied by lagged NMMOB. As measures of the quantity or quality of the available labour supply, we also considered man-days lost in strikes and the unemployment rate. These variables did not improve our equation.

The standard error of estimate is 26.3 thousand men, less than .65% of the average value of NMMOB in 1968. The coefficient on the short gap implies a slow adjustment, in response to a current labour excess or shortage, of about 12.1% in the current quarter.

2 The hours equation

The basic causal variable in equation 5.3 for HAWMM is the proportion of the desired labour input (NMMOBD) that is not met by current employment. The dependent variable is the difference between actual and normal weekly hours expressed as a proportion of normal weekly hours. This specification has been chosen because the basic input to the production function is expressed in terms of man-hours, which we approximate by (HAWMM)(NMMOB). A given increase in required man-hours can be met by an increase in men or a similar percentage increase in hours. We suppose that hours are a short-run rather than a long-run source of labour, having assumed that in the long run average weekly hours follow a downward trend in response to the general demand for more leisure. Thus our hours gap has nonzero values only to the extent that current employment (assuming normal hours are worked)

does not provide for current labour requirements as measured by the short-gap variable.

The coefficient on the labour gap suggests that 13% of the labour requirement not met by current employment is met by changes in hours worked. The remaining short-term variations in output are presumably accommodated by changes in the degree of utilization of employed factors (i.e. short-term changes in factor productivity). The standard error of estimate is about .2 hours, or .5% of the average value of HAWMM.

C Employment and Hours in Construction

Three approaches to equations 5.2 and 5.4 were tried, starting with a simplified version of the hierarchical model used for the main business employment and hours equations. We turned to simpler models when this model did not prove to be applicable to the construction industry. We treated construction separately because we can employ the endogenous output variable IRC+INRC and thereby obtain a better explanation of the construction wage needed in equations 7.6 and 7.7 for construction prices.

1 Hierarchical adjustment

This specification is parallel to the employment and hours equations in mining, manufacturing, and other business but it did not work satisfactorily. A stock-adjustment model was assumed for man-hours - the labour input to the construction industry.

Firms were assumed to have a desired level of man-hours, which depends on seasonal factors, the trend of investment in construction, the deviation of investment from this trend, and unemployment in the economy as a whole. It was further assumed, and experiments supported the assumption, that low unemployment indicates difficulty in recruiting competent workers, so that marginal man-hour requirements increase. The lagged adjustment of man-hours to desired man-hours gave a good equation for man-hours, and from it we obtained the coefficients of the determinants of desired man-hours. The desired level of employment was assumed to be such as would provide the desired man-hour input at the standard work week, which we took to be the linear trend value of average weekly hours in construction. A regression of actual employment (NC) on desired employment and lagged actual employment fitted well. The next step was to explain the actual hours worked in terms of the desired man-hours unfilled by adjustments in the level of employment. However, in none of the specifications we tried for average weekly hours was this gap a significant variable. Linear seasonal variables accounted for most of the variation in hours, and the unfilled gap alone did not provide much explanatory power.

2 Separate equations for total man-hours and employment

One alternative to our first approach is to construct an equation for the lagged adjustment of man-hours to desired man-hours, as well as an equation with similar explanatory variables describing the lagged adjustment of men to desired men and

defining average weekly hours by means of the identity linking employment, average hours, and total man-hours. Although the explanatory power of this specification was quite good, examination of the coefficients showed no difference in structure between the man-hours and the employment equations. In particular, the speed of adjustment to desired man-hours was no quicker than the speed of adjustment to the desired level of employment. This finding conflicts with our general theory of employment adjustment, according to which overtime temporarily provides for an increase in desired labour input, if the increase in demand is judged to be permanent, until hiring of men can fill the gap. Thus our residual, hours, was mainly capturing seasonal fluctuations. It was not determined by economic factors.

3 Separate equations for employment and average hours

The specification finally adopted has independent equations for men and for hours. The constrained quarterly variables appear with substantial coefficients in equation 5.2 for paid employees in construction, reflecting seasonal employment movements independent of the level of construction activity. The trend in required employment, as the construction industry expands, is represented by a twelve-quarter moving average of the sum of residential construction and non-residential construction investment. The rate of unemployment helps to explain in two ways the number of men employed. When the construction industry is slack, indicated by high unemployment, firms do not trim their labour force proportionately. They use their workers less

intensively, reducing hours and fostering some paid underemployment. The hoarding of workers is logical, considering hiring costs and the danger of losing competent workers to other firms when construction picks up. The second effect concerns the hiring of marginal workers during a boom. In these circumstances, the need for more workers forces firms operating in a tight labour market to hire people with lower productivity than the firms' regular, experienced employees. The low level of unemployment indicates that the supply of competent workers is becoming exhausted and that marginal workers have to be hired. Conversely, when unemployment is high it is relatively easier to find good people; hence fewer people are needed for a given level of output in the construction industry. We use the unemployment rate for the whole economy as a proxy for the rate of unemployment in the market for actual and potential construction workers.

The difference between the current level of construction investment and its moving average enters the equation because we assume that some of the increase in the industry's output is achieved by hiring more men currently. In this context, we tried the ratio of the wage rate to construction materials costs, on the assumption that prefabricated materials bought from other industries could be substituted for labour according to relative prices. This ratio did not help the equation. Finally, the employment equation contains the lagged dependent variable, since we hypothesize a lagged adjustment to the desired level of employment. The RB2 for equation 5.2 is .983, and its standard

error is 6.7 thousand men, about 2% of the average number employed.

Equation 5.4 for average weekly hours worked in construction (HAWC) contains a constant, constrained seasonals, and the difference between current investment in non-residential construction and its twelve-quarter moving average. The constrained seasonal variables are of substantial importance; as a group they explain about 80% of the variance in hours. As expected, an activity variable in construction does account for some of the movement in hours. We tried other cyclical variables - such as the ratio of investment in construction to the capacity output of the economy as a whole, or to the moving average of investment - but none performed as well as the one chosen. In particular, investment in non-residential construction alone was better than total construction investment or investment in residential construction alone. Two reasons for this occur to us. Residential construction is supposed to be counter-cyclical to some extent (in fact the sign of the coefficient on IRC minus its twelve-quarter moving average was negative). An alternative explanation is that non-residential construction is probably done by large firms, and the surveys of large establishments give us our data for average weekly hours.

Equation 5.4 has an RB2 of .889 and a standard error of about .5 hours.

D Labour Force Participation

Equation 5.5 for the labour force (NL) is similar to that used in RDX1. The variables carried over from RDX1 include the proportion of the labour force population in school, and personal real disposable income per member of the labour force population. The labour force population (NPOP) is defined as the noninstitutional population 14 years of age and over. The relevant school population (NPOPSS) therefore includes all those 14 and over attending schools or post-secondary educational institutions full time.

The dependent variable in equation 5.5 is the first difference of the participation rate, measured as a percentage. The first difference in the percentage of the labour force population in school enters the equation twice, once multiplied by Q1+Q2 and again multiplied by Q3+Q4. Both expressions have negative coefficients, naturally enough. The variable for the second half of the calendar year has a larger coefficient, presumably because the academic year starts about the end of the third quarter.

The income variable helps the equation, whereas two more defensible alternatives - the degree of capacity utilization, and the unemployment rate - do not. Thus we have a personal income variable supposedly standing for the marginal benefits of labour force participation.

We took advantage of our population change equations to add a new variable to the participation-rate equation - the first difference in a nineteen-quarter moving sum of immigration minus

emigration. The underlying theoretical assumption here is that immigrants and emigrants are more likely than other members of the population 14 years of age and over to be members of the labour force. To some extent this variable may be picking up indirectly the influence of unemployment on the participation rate, because net immigration is negatively related to recent unemployment rates.

The equation has an RB2 of .982 and a standard error of about .19 per cent of the labour force population.

E International Migration

Our equations for population movements are for total immigration and total emigration. The former is measured with reasonable precision, but the figures for total emigration are defined as a residual in the population balance sheet. The division of population flows between those to and from the United States and those to and from other countries would provide greater symmetry with our treatment of trade and capital flows. However, we can specify our aggregate immigration and emigration equations to reflect the effects of U.S. economic variables on migration to and from Canada. What we cannot do, with our present equations, is show the influence of Canadian-U.S. migratory flows on the U.S. population. Because these movements are small relative to the total U.S. population, our aggregate treatment is probably adequate. We are more interested in the

ten times larger relative influence of the migratory flows on the Canadian population and labour force.

Our fairly crude equations for immigration (NIMS, equation 5.6) and emigration (NEMS, equation 5.7) both depend strongly on the Canadian unemployment rate. For the emigration equation the reasoning is fairly unambiguous - higher unemployment in Canada provides a push for Canadians to look elsewhere for jobs. In the immigration equation, where the impact of the Canadian unemployment rate is much stronger, the causality is less easy to identify. When the Canadian rate of unemployment is very low, immigration to Canada is attractive because jobs are plentiful. However, a more important direct result may be the higher level of advertising and official encouragement offered by federal and provincial governments as well as private business firms. We should like to separate the effects of federal government expenditure designed to encourage immigration, but the difficulties of measuring the policy component of the relevant expenditures and the problem of collinearity with the general unemployment rate thwarted our preliminary efforts.

Both migration equations are estimated in ratio form, with the labour force population (NPOP) in the denominator. In addition to the Canadian unemployment rate, the immigration equation depends on an eight-quarter distributed lag on the ratio of the Canadian real wage to a weighted index of real wages in Great Britain, Italy, Germany and the United States. For each of the three European countries, the largest providers of emigrants to Canada, the real wage is defined as a wage index divided by a consumer price index. The combined European real wage rate index

(EWEURO) uses weights of .54, .32, and .14 on the real wage indexes of Great Britain, Italy, and West Germany, respectively. The weights are proportional to the total 1956-1968 migration from each of these countries to Canada. The European real wage rate index, which has a base 1961=1, is combined with the U.S. real wage (after the latter is put on a base 1961=1) using weights of .86 on EWEURO and .14 on the U.S. real wage index. These weights depend on the 1956-1968 migration from the United States and from the three European countries. These four countries provided 1.15 million of the 1.88 million Canadian immigrants during the period 1956-1968.

Although the final equation uses the Canadian and foreign real wages in ratio form, we also estimated equations into which the Canadian and foreign wage rate variables entered separately. The sums of coefficients on the two variables were almost exactly the same, but the average lag on the Canadian real wage variable was longer than on the foreign real wage variable. This may be due either to longer lags in finding out about wages and prices in countries other than where one is living, or to the fact that the real wage index is one of two variables measuring current Canadian economic conditions. Because of this difference in lag structures, the Canadian real wage enters the ratio with a one-quarter lag in the final equation.

The effect on immigration of changes in the Canadian unemployment rate is greater than the effect of changes in real wage rates, although adjustments to a new level of the unemployment rate take longer to work themselves out. The estimated coefficients are such that a decrease in RNU from 5% to

4% will increase the average inflow of immigrants by about 43% over a three-year period, with no effect at all for the first two quarters. By comparison, a 10% increase in the Canadian real wage rate, relative to that of the source countries, will increase the average flow of NIMS by almost 18% over eight quarters.

The NIMS equation also contains an eight-quarter distributed lag on NPOP. There is no reason to suppose that the elasticity of NIMS with respect to NPOP should be unity, and indeed we suspect that a rapidly growing domestic labour force population, with the unemployment rate and relative wage rates unchanged, should discourage immigration. In fact the estimated elasticity of the dependent variable with respect to NPOP is -1.5, implying in equilibrium a .5% decrease in immigration for a 1% increase in NPOP.

The emigration equation (equation 5.7) has a constant term, three constrained quarterlies, and lags of five quarters with declining weights on four-quarter moving averages of the reciprocals of the Canadian and the U.S. unemployment rates. Both rates enter significantly with opposite signs. The slightly greater coefficient on the U.S. rate as opposed to that on the Canadian rate not only illustrates that the United States is the major recipient of Canadian emigration, but suggests that the 'pull' from job opportunities there may be stronger than the 'push' from the existence of unemployment in Canada. We also tried variables for the real wage differential between Canada and the United States, the tightening of the U.S. immigration laws at the end of 1965, and for the influence of recent immigration from

Europe on subsequent emigration to the United States. None helped the equation significantly, and the relatively low RB2 of .321 probably demonstrates, as much as anything else, the fact that emigration flows are defined as a residual in the rather imprecisely measured population balance sheet.

Both migration equations show a substantial impact of current economic conditions on migration flows; more than enough to justify the inclusion of the migration equations in RDX2.

CHAPTER 6

INCOME DISTRIBUTION: WAGES, PROFITS, AND DIVIDENDS

SECTORS 6 AND 8

A Introduction

The equations described in this chapter explain the distribution of business income between wages and profits, the allocation of profits between dividends and retained earnings, and the compilation of personal income. The relevant equations are not all in Sectors 6 and 8, for, in order to determine the private sector wage bill, the wage rate equations of Sector 6 must be combined with the employment equations of Sector 5. We complete the explanation of total personal income distribution in Chapter 8 where we explain incomes arising from transfer payments and employment by government, as well as income redistribution through the tax system.

RDX2 has explicit equations for all the main components of the income side and the expenditure side of the national accounts, in both current and constant dollars. We carry further than we did in RDX1 the application of a complete set of income distribution equations, and follow the RDX1 procedure of using the national accounts identity to determine the residual income item YRES. Because we treat the national accounts residuals (ENARES and ENARES$) as exogenous variables, YRES is

the net solution error from the income and expenditure equations. Under an expansionary simulation, a series of positive values for YRES would provide a measure of the extent to which our income distribution mechanism fails to distribute fully the increase in gross national expenditure. For purposes of simulation, we treat YRES as though it were part of total personal income (YP). Alternative ways of disposing of YRES are possible. Simulations will show whether YRES ever gets large enough to make the choice an important one.

We proceed, in section B, to explain the business wage rate equations and the wage bill identity of Sector 6, and in section C to describe the profits and dividends equations of Sector 8. Section D at the end of the chapter is a brief summary of the various personal and national income identities contained in Sector 8.

B Business Quarterly Wage Rates

We explain two business quarterly wage rates, one for mining, manufacturing, and other business (WQMMOB), and the other for construction (WQC). The first applies to over 80% of total business employment; the second is important more because of its links with construction prices than because of its impact on the total wage bill.

1 A model of the real wage level in mining, manufacturing, and other business (Equation 6.1)

In RDX1, we employed a business wage rate equation of a typical sort (e.g. [4], [48], [49]) wherein the four-quarter percentage change in the money wage rate depended on changes in consumer prices, profits per unit of output, and on the dependent variable lagged four quarters. In constructing RDX2, we have taken advantage of our integrated model of production, employment, and investment to develop an equation for the level of the real wage in mining, manufacturing, and other business. As parts of the grand set of assumptions underlying our production model, we have measures of both trends and short-term changes in labour productivity. The long-term productivity variable (ELEFF) becomes the main determinant of the real wage. As well, the short-term productivity measures were given a chance to enter the equation.

The unusual feature of the WQMMOB equation is that the money wage moves towards an equilibrium real wage. This specification differs from that used by Kuh [38] in which the money wage rate moves towards an equilibrium money wage. The difference is not great, for Kuh's equilibrium money wage depends on the price level along with productivity and the unemployment rate. In equation 6.1 the dependent variable is the one-quarter percentage change in WQMMOB. Consumer prices, measured by the Consumer Price Index (PCPI), enter the WQMMOB equation twice: in the denominator of the lagged real wage, and then separately in the form of PCPICE, the expected annual percentage change in the

Consumer Price Index. Other variables in the equation include the labour efficiency factor (ELEFF), a nonlinear transformation of the unemployment rate and the dependent variable lagged four quarters.

This structure requires some explanation. The equilibrium level of the real wage is determined primarily by ELEFF, a synthetic variable having a sample mean of 1 and representing the level of labour efficiency. The coefficient on ELEFF is slightly below that on the lagged real wage. Both variables have approximately the same sample means, so that a 1% increase in our measure of labour efficiency leads to a .87% increase in the real wage. The unemployment variable is an eight-quarter linear lag distribution on the square of the ratio of the labour force to the number of unemployed. The influence of this variable is slight and does not increase if the specification is changed to permit an additional impact in the short run. Why should the unemployment rate influence the equilibrium real wage? Alternative rationales are available. On the one hand, workers of differing efficiency may be paid the same money wage thereby encouraging employers to lay off the least efficient workers first. Thus the marginal product of labour and the rate of unemployment increase and decrease together. On the other hand, the existence of a large 'reserve army of the unemployed' reduces the bargaining power of wage and salary earners and hence lowers the equilibrium real wage.

What kind of wage behaviour is implied by the equation taken as a whole? In a stationary situation with constant prices and no increases in efficiency there would be no expectation of price

increases, and the real wage level would be determined by the existing level of ELEFF and the unemployment rate. With increasing prices and constant labour efficiency, the Consumer Price Index and the quarterly wage (WQMMOB) would grow at about the same rate. Although the equilibrium coefficient on PCPICE is larger than .25, PCPICE has weights summing to less than 1 on past changes in PCPI. (See equation 18.2.) If the equilibrium coefficient on PCPICE were above .25 by exactly the same proportion that the PCPI weights in the PCPICE equation fall short of 1, then inflation in the Consumer Price Index, unaccompanied by any change in ELEFF or the unemployment rate, would not lead to any change in the real wage. The relevant value is .25 because an annual percentage change in prices is being compared with a quarterly percentage change in the wage rate. Although the relevant coefficients are estimated imprecisely they show the absence of money illusion in the wage bargain.

The structure of our wage adjustment equation is such that if the coefficient on PCPICE were very low, indicating some money illusion, the result would not be a drop in the rate of increase of the real wage, although this would be the case in the usual wage change equations. Our equation would reveal a drop in the level of the real wage until the point is reached where prices and wages grow at the same rate. In equation 6.1, therefore, money illusion does not mean a continually dropping real wage in the presence of inflation, but a real wage that is lower than it would have been in the absence of inflation.

2 Quarterly wage rate in construction (Equation 6.2)

The construction wage rate equation (WQC) is of lesser importance than the equation for WQMMOB, and is of a more usual type. The fit is good, with an RB2 of .974 using one-quarter percentage changes in WQC as the dependent variable. The independent variables are the expected rate of change of prices, the inverse of the unemployment rate, and the one-quarter percentage change in average weekly hours in construction. The coefficient slightly greater than 1 on the average weekly hours variable suggests that the other variables determine the average hourly wage, with increases in hours worked leading to slightly more than proportionate increases in the average quarterly wage.

The coefficient on PCPICE is well above .25, indicating that, other things equal, the construction wage rises faster than the expected rate of price increase. The influence of the unemployment rate is substantial, being such that a drop in the unemployment rate from 6% to 5% would increase the rate of growth of the quarterly wage rate in construction by .36% per quarter.

The technical relationship appearing at the end of Sector 6 shows the accumulation of the total wage bill (YW) from the component wage rate series and employment series. There are five endogenous employment series. Business employment (NMMOB and NC) is explained in Sector 5 and employment in federal administration (NGPAF) in Sector 12. The remaining equations for employment in provincial and municipal administration (NGPAPM) and in elementary and secondary schools (NIS) are located in Sector 13. The business wage rate equations are explained in this chapter.

The government administration wage rate equations are in Sectors 12 and 13 and explained in Chapter 8.

The exogenous series for paid employment in agriculture (NFP) and in noncommercial institutions other than schools (NIOS) were multiplied by the corresponding exogenous wage rate series to obtain the relevant components of the wage bill. Taken together, these exogenous components are relatively small, averaging less than 8% of the total wage bill over the period 1952-1968. The remaining components of the wage bill are total wage supplements in business (YWSLP), schools (GWSSM), and government administration (GWSF, GWPASPM).

C Corporate Profits and Dividends

Equation 8.1 for profits of corporations represents our crude attempt to construct an aggregate profit and loss account for the corporate sector. The first variable is the sum of corporate bond interest payments (ECINT) and current-dollar capital consumption allowances (CCAC$). These are the best variables we could find to measure the relevant accounting charges for the use of capital. The coefficient on this variable is well over 1, possibly because of cyclicity in omitted corporate interest payments or because variations in book depreciation allowances are not reflected in the national accounts.

To represent sales plus inventory accumulation, we use the current-dollar value of business output net of the income of

unincorporated business (YGPP-YNFNC), minus total indirect taxes less subsidies (TILGS). The cost of labour is represented by the business sector wage bill, including supplements. Both the revenue and labour cost variables have strong coefficients slightly less than 1 in value - an appropriate result since both contain portions relating to the unincorporated business sector.

The equation as a whole is very satisfactory, with a standard error of $39.2 million, slightly over 3% of the sample average. The theory of profits underlying the accounting relationship is made explicit in our equations for factor demands, inventory accumulation, aggregate supply and demand, and price and wage formation. Because of various lags in the factor-demand equations, there are short-run changes in factor productivity that lead to short-term changes in profits not fully reflected by changes in the supply price of capital or the market value of the business capital stock. Thus we smooth the profits series slightly, by taking a four-quarter moving sum, to approximate a normal profits series in the Sector 18 equations defining the supply price of capital.

There are two dividend equations in Sector 8 - equation 8.2 for dividends paid to Canadian residents (YDIV11) and equation 8.3 for dividends paid to foreign shareholders (YDIVF). Both equations assume Lintner-type [40] distributed lag adjustment of dividends to changes in the relevant measures of after-tax profits plus book depreciation. The proportion of total cash flow attributable to each type of shareholder is determined by our measures of the international indebtedness of Canadians

(LDIRV12, LPCV12 and LDIPRV13) in conjunction with the replacement value of the business capital stock (KB$).

Alternative equations were fitted using profits rather than cash flow as the driving variable, but in each case the profits version fitted less well than the cash flow version. The equilibrium dividend payout ratios with respect to the relevant measures of cash flow can be derived by taking account of the coefficient on the lagged dependent variable and noting that the cash flow variable is defined as a four-quarter sum. For dividends paid to Canadians, the payout ratio is 23.0% of cash flow (equivalent to 41.5% of after-tax profits). For dividends paid to foreigners, the ratio is 22.6% of cash flow corresponding to 40.6% of profits. The conversion from a cash flow to a profits basis is made by using the ratio of cash flow to after-tax profits in 1968. The response pattern appears to be slower for dividends paid to foreign shareholders than for dividends paid to Canadians.

Equation 8.3 for YDIVF is needed to complete the definition of undistributed corporate profits (YCR, equation 8.10). We treat dividend payments to the United States (MDIV$12) separately in equation 4.17, and combine dividend and interest payments to other countries (MID$13) in equation 4.20. The dividend series in the foreign trade sector are measured net of withholding tax, whereas YDIVF takes no account of that tax.

D Some Income Accounting

In equation 8.4, current-dollar gross national expenditure (YGNE) is defined as the sum of its components. Equation 8.5 contains YGPP, the current-dollar definition of the business real output variable (UGPP) described in Chapter 3. The remaining technical relationships in Sector 8 include the simulation residual, YRES, described at the beginning of this chapter, four personal income concepts, and our measure of revaluation gains and losses. Disposable wage income (YDW, equation 8.6) is based on the wage bill, military pay, nonfarm non-corporate income, and the relevant tax and transfer items applicable to wage income. Disposable wage income is defined separately because it is used in our consumption equations. Equations 8.8 and 8.9 contain the usual definitions of personal income (YP) and personal disposable income (YDP). In equations 8.11 and 8.12 we define series for permanent disposable nonwage personal income (YPDNWP) and for capital gains on equities and bonds (YKGP). These identities are discussed in part 2.2 and part 2.3 of section A in Chapter 2.

CHAPTER 7

PRICE FORMATION

SECTOR 7

A General Features of Price Equations

Our approach to price explanation in RDX2 involves separate equations for each main component of aggregate demand and for each main category of imports and exports of goods. The aggregate national accounts deflator (PGNE) and the private product deflator (PGPP) are then determined as the ratios of the relevant current- and constant-dollar totals. The Consumer Price Index (PCPI) is explained by a base-weighted average of the appropriate final demand deflators. By specifying and estimating equations for disaggregated prices, we found ourselves better able than we were in RDX1 to estimate the appropriate impacts of foreign influences, supply and demand imbalance, and indirect taxes.

Although we have twenty separate stochastic price equations, each equation still represents such a wide range of industry behaviour that no one simple model can apply to all. Consequently we have tried to find suitable explanatory roles for a number of influences that are important in one or more sorts of pricing theory.

1 Cost factors

Most theories attach considerable importance to the role of unit labour costs. 'Normal' unit labour costs are given a key role in mark-up theories used to explain price determination when price changes are potentially costly to make or administer. (See [16] and [39].) In models based on short-run profit maximization under competitive conditions (e.g. [16] pp. 1160-1162), current unit labour costs play the dominant role. From the point of view of builders of macroeconomic models, the choice is a crucial one. If current rather than 'normal' unit labour costs are used, the typically high coefficient obtained on the unit labour cost variable is likely to produce the simulation result that any increase in aggregate demand will cause prices to drop for several quarters until wage rates and employment rise enough to offset the increase in output. The reason for this result is that employment is more stable than output, leading to short-term changes in labour productivity when output levels change. In order to avoid this problem, we ought to specify price equations that allow short-run productivity changes and other factors influencing unit labour costs to have separately estimated effects. Obviously, a reasonable theory of productivity changes is required here.

Within RDX2 there is a theory of short-run productivity changes implied by the lagged adjustments to changes in capital and labour requirements. We have explained in Chapter 3 and Chapter 5 the mechanisms whereby unexpected changes in final demand give rise to unintended inventory changes and to changes

in the degree of utilization of employed capital and labour, as well as to the usual changes in average weekly hours, employment and investment. The changes in the degree of utilization of employed labour and capital define what are usually referred to as short-term changes in labour productivity. The asymmetry in the treatment of capital and labour probably arises because machines and buildings are not 'hired' and 'laid off' in an easily measurable way. Thus we cannot make a split, as we can for the labour market, between changes in the employment of capital goods and changes in the degree of utilization of employed capital goods. Even if this distinction were possible, it would not be possible to make separate attributions of changes in output to changes in the degree of utilization of employed labour and capital. Whether or not we follow usual practice in referring to the whole change in output not explained by changes in hours, employment, and capital goods as a change in labour productivity, we need to isolate this change.

Within RDX2 the short-term productivity variable can be defined as the reciprocal of the ratio of actual employment to the equilibrium level of employment, which is that level required to produce current output less unintended inventory changes (UGPPA), assuming the same length of work week in both cases. The equilibrium level of employment is derived by assuming the production function to hold exactly. For any given level of UGPPA, this equilibrium labour input falls over time according to the rate of Harrod-neutral technical progress built into the production function.

Corresponding definitions of 'normal' factor cost are obtained by dividing the total cost of factor inputs by the amount of output (UGPPS) that would be produced if the existing capital stock, employment, and average weekly hours were combined according to the assumed production function for UGPP.

Most price equations take account only of normal unit labour costs, and sometimes a variable for purchased materials. Such specifications ignore the effects of factor substitution in response to changes in technology or in relative factor prices. If capital is substituted for labour, total factor costs per unit of output will either rise faster or fall more slowly than unit labour costs. We have been able to consider factor costs fairly completely in RDX2 by developing series for unit labour costs and unit capital costs, with unit factor costs as the sum of the two. The capital cost variable is obtained separately for each type of capital as the product of the net constant-dollar stock, the current replacement price, and the expected user (or owner) cost of capital for that type of capital. The fact that this variable did not improve most of the price equations may be considered a vindication of the traditional theory of mark-up pricing based on normal unit variable costs, or as evidence that we have failed to measure adequately the relevant costs of owning capital goods. Normal unit labour costs and capital costs enter separately in equation 7.10 for the price of non-residential construction materials.

The costs of materials are separately introduced in our construction deflators, but otherwise are not available in suitable form for use in explaining final demand prices.

Naturally we must take account of the prices of imported materials, and we do so in the manner to be explained in part 3 of this section.

2 Supply and demand

When price changes are costly or when prices are sluggish for other reasons any existing pattern of prices may give rise to an imbalance between supply and demand. If prices play any allocative role at all, this imbalance will affect price movements. The imbalance of supply and demand at existing prices has both stock and flow dimensions, and we attempt to take both into account. In flow terms we use the ratio of aggregate demand (UGPPA), i.e. output excluding unintended inventory changes, to 'desired' output (UGPPD). Desired output is what the production function would yield at average rates of employment and factor utilization. Both concepts have been described more fully in Chapter 3. In stock terms we use an approximation (being a twelve-quarter moving sum) to the cumulant of unintended inventory accumulation or decumulation. As long as inventory stocks are deemed to be excess by their holders, downward pressure on prices will occur whatever the flow relation between current demand and output. We think the moving sum of UGPP-UGPPA is more appropriate than the stock/sales ratio used in RDX1, because the former concept explicitly allows for cyclical changes in the desired stock/sales ratio resulting from changes in expected future sales.

3 Foreign influences

Foreign prices and activity can influence domestic prices in several ways. First, changes in foreign aggregate demand may lead, through changes in exports, to pressures on domestic prices. Unless the relevant characteristics of exports are different from those of other components of aggregate demand, these pressures are captured by the general measures of supply/demand imbalance described above.

Second, foreign prices influence domestic final demand prices because of the import content in each final demand category. We have attempted to obtain measures of the landed Canadian price of the import content of each expenditure category, usually based on some weighted average of relevant U.S. prices multiplied by the exchange rate.

Third, a number of domestically produced goods may be priced, other things equal, to compete with imported or importable substitutes. Some other Canadian products are sold in world markets or in particular foreign countries, or are potentially salable in such markets. As well, the prices of Canadian goods actually exported are naturally explained in part by foreign or world market prices. Prices of certain goods used in Canada (such as the forest products components of residential construction materials) are also affected directly by the prices available in export markets.

Finally, numerous other international links, especially between the United States and Canada, may lead to joint movement of prices. If Canadian and U.S. firms producing for their

national markets are under common management, price changes are more likely to be made in concert than when producers of corresponding goods in the two countries are unrelated. We do not doubt that a considerable amount of international price discrimination may occur, but once the related firms have decided on the appropriate amount of the differential, any subsequent price changes are more likely to be coincident when the major firms operate in both markets. If we employ U.S. price variables directly in corresponding Canadian price equations so as to reflect some of these ill-defined organizational links, we must be satisfied that excessive importance is not attached to the U.S. price merely because of the influence of shocks (omitted variables) common to both economies. If we are careful in the choice of instrumental variables, our simultaneous equation estimation method should protect our parameter estimates from this sort of bias.

4 The influence of sales taxes

One of the potential gains from our disaggregation of price explanation is that we may be able to estimate the effects of sales taxes on price formation. There are two main categories of sales tax in Canada - the manufacturers sales tax levied by the federal government and the retail sales taxes levied by all the provincial governments' except the government of Alberta. Current-dollar national accounts expenditures include sales taxes, so that these taxes are automatically built into the measured prices. Only the manufacturers sales tax applies to

business investment and to residential construction expenditure, whereas different types of consumer expenditure are subject to varying amounts of both the manufacturers and the retail sales tax.

The dependent variables in most of our price equations are purged of sales taxes applied at the final point of sale. We did not attempt to calculate the impact of the manufacturers sales tax on retail prices of consumer items, because we lack the information to construct an appropriate weighted tax rate and because there has been no substantial variation in the basic rate applicable to consumer goods. The effects of the tax on investment goods are easier and more important to measure, since production machinery and building materials were both subject to varying degrees of tax exemption during the sample period. (See [28], p.69.)

Thus the machinery and equipment price and the prices of building materials are purged of the manufacturers sales tax, and consumer prices are purged of a weighted average of retail sales tax rates. Purging involves division of the measured price by 1 plus the relevant tax rate measured as a proportion. If the independent variables explaining the purged price do not include the sales tax rate, this procedure implies that (ignoring the indirect effects) any change in the rate of sales tax under simulation will produce a corresponding change in the price to the purchaser. In all our equations we generalize this procedure so that the tax may lead to changes in demand that affect the eventual price to the producer. This possibility is allowed for by trying a distributed lag on the tax rate as an explanatory

variable in each purged price equation. Although the dynamic pattern of response may differ from price to price, in most markets we would expect the sum of weights on the tax variable (measured as a proportion) to be between 0 and -1.

In the following sections we explain how the general factors outlined above are depicted in our equations. We describe the equations for the main domestic expenditure deflators in section B, for the prices of imports and exports in section C, and for the derived aggregate prices in section D.

B Domestic Expenditure Prices

Here we explain the equations for four categories of consumption expenditure, four types of private investment expenditure (plus two related equations for the prices of construction materials), and three categories of government expenditure. We leave until section D the description of how our estimate of the Consumer Price Index is derived from the national accounts deflators. For most of the price equations the standard error of estimate and the coefficient of variation are very close in size, since all prices have the base 1961=1. Although most of the price level equations have very low Durbin-Watson statistics, re-estimation to remove the first-order autocorrelation by the Hildreth-Lu technique did not affect these equations materially. All quoted elasticities were estimated by using the ordinary least squares coefficients and the sample means of the variables.

1 Consumer prices

The four equations discussed here are for the prices of non-durables and semi-durables, services, consumer motor vehicles, and other consumer durables.

PCNDSD Price of consumer non-durables and semi-durables (Equation 7.1)

In this equation the implicit deflator is explained by normal unit labour costs, a weighted average of U.S. prices, and the retail sales tax rate variable. Normal unit labour costs are defined as the ratio of the wage bills in mining, manufacturing, and other business, and in construction to UGPPS, and enter the equation in an eight-quarter lag distribution. The equilibrium partial elasticity of PCNDSD with respect to normal unit labour costs is about .76. The elasticity with respect to the import price, which is weighted according to the CNDSD content of each of the five main categories of goods imports, is about .11, slightly below the likely import content in consumer expenditure on non-durable and semi-durable goods. The pattern of weights on the retail sales tax rate indicates that for an increase of one percentage point in RTISPM the purged price falls in the first two quarters by almost 1%, but then starts to rise again so that in equilibrium there is only a .2% decline in the purged price and almost all of the tax increase is passed on to consumers.

PCS Price of consumer services (Equation 7.2)

This index is constructed primarily from wage rate data, and that is the way our equation explains it. The close-fitting equation is based on the quarterly wage rate (WQMMOB), the sales tax rate multiplied by the lagged price index, and the three constrained seasonal variables multiplied by the lagged dependent variable. The coefficient of -.76 on the sales tax rate variable is high partly because most consumer services are not subject to the retail sales tax.

PCMV Price of consumer motor vehicles (Equation 7.3)

The nature of the Canadian car industry has been changing ever since the Canada-United States Automotive Agreement took effect in the mid-1960s. Under this agreement the removal of tariffs on autos and parts is tied to certain broad rules of production sharing. Two results have been the growing integration of the North American auto industry and the establishment of auto assembly plants in Canada by other foreign manufacturers. One of the announced aims of the pact is lower Canadian car prices. However, it is hard for us to be precise about price consequences because of the complicated structure of the industry and the basic difficulties we encountered in constructing the price data. In our attempt to capture the price effects of the auto pact, we employ the variable QAUTO used in the auto trade equations to represent the increasing rationalization of the North American auto industry.

Our equation combines a unit labour costs variable, the price of U.S. consumer durables (multiplied by the exchange

rate), a time trend, the short-term productivity variable, and the auto pact variable already described. The estimated parameters show a very high elasticity with respect to normal unit labour costs, offset by a strong downward time trend and a strong effect of the auto pact variable. These results may flow directly from the quality of the basic data, but they may nevertheless raise problems under simulation. A 1% increase in normal unit labour costs in the business sector has a partial impact on PCMV of 4% to 5%, spread over three years. The partial elasticity with respect to the U.S. price is slightly less than 1. These generally upward influences are offset, in our estimated equation, by a quarterly time-related rate of price reduction of almost 2%.

Consumer durables, both cars and other durables, are the only national accounts categories where serious attempts have been made to account for quality changes. These prices have therefore risen less rapidly than the other national accounts deflators. If price adjustments for quality change are made either in a regular manner or in some other way unrelated to cost and demand forces, then the use of time trends in the price level equations may be the best way of allowing for these adjustments.

PCDO Price of other consumer durables (Equation 7.4)

When the PCDO equation is estimated with a linear time trend along with the endogenous causal variables, it has a standard error of about .7%, sensible coefficients on the structural variables, and a downward time trend (all else held constant) of .47% per quarter. This is offset by a high elasticity (about

1.37) of PCDO with respect to normal unit labour costs. The cyclical productivity variable has a modest impact, the elasticity of price being about .17 with respect to the ratio of actual to desired employment. The elasticity with respect to the U.S. consumer durables price multiplied by the exchange rate is .28. This is slightly more than the direct import content, but the excess is easily explained by the pricing of domestic production to match the landed price of imports.

The distributed lag on the sales tax variable has a sum of weights of -.69, suggesting an unrealistically high price-elasticity of demand by consumers. The equation suggests that the final price rises only .3% for a 1 percentage point increase in retail sales tax rates. Part of the difficulty in estimating realistic coefficients on the sales tax variable arises from its close approximation to a time trend. (The simple correlation between QTIME and the Almon variable for RTISPM is .94.) Taking more explicit account of federal sales and excise taxes may help, but here also there is little variance in the tax rates applicable to consumer durables.

2 Investment prices

PIME Price deflator for business investment in machinery and equipment (Equation 7.5)

The equation for the purged price is driven by distributed lags on the price of machinery imported from the United States (PPD2) times the exchange rate, normal unit labour costs, the manufacturers sales tax rate applicable to machinery and

equipment, the corresponding U.S. price entering on its own, and a four-quarter moving average of UGPPA/UGPPD, the flow measure of demand/supply imbalance.

The sales tax variable used here is a weighted average of that applicable to production machinery and equipment (about 88% of the total) and that applicable to other machinery and equipment, chiefly motor vehicles. The coefficients on the sales tax variable show a significant amount of realignment of pre-tax prices for a given change in sales tax rates. The large changes in the rates applicable to production machinery and equipment (see [28], p.69) give this variable a substantial amount of independent variance and allow us to place more reliance on the resulting coefficients. Initially a large amount of the tax is absorbed by sellers (about half after two quarters), but this proportion is subsequently reduced to 35% as new catalogues and contracts come into force in later quarters.

The elasticity of PIME with respect to unit labour costs is about .25, spread over five quarters according to a series of declining weights. The U.S. price multiplied by the exchange rate has a sum of coefficients equal to .35, slightly less than the import content of IME. However, there is a substantial additional impact from the U.S. price entering on its own. Since this variable has an insignificant weight in the current quarter, it cannot simply be reflecting coordinated pricing decisions made under common management unless the U.S. national accounts prices reflect actual price changes on a more current basis than the Canadian statistics. Another way of interpreting the variable is to assume that some of the variance in prices caused by changes

in PFX is absorbed by the U.S. exporters of machines to Canada. This would cause PPD2 to enter alone as well as multiplied by PFX.

The capacity utilization variable has coefficients summing to .25 on a four-quarter moving average of UGPPA/UGPPD. This corresponds roughly to an elasticity of the same magnitude. The equation as a whole fits closely, with an RB2 of .996 and a coefficient of variation of .54%.

PIRC Price deflator for private investment in residential construction (Equation 7.6)

Both construction deflators have the same equation structure based on the costs of labour and materials. This is consistent with the procedures used in constructing the indices. Since it is hard to define a unit of construction output and since little information has been collected on bid prices, the national accounts deflators for both residential and non-residential construction are based on the assumption of a fixed ratio of output to materials input (following [13]).

Our equation shows PIRC responding with lags to the quarterly wage in construction and the price of materials used in residential construction. The elasticity of PIRC with respect to the materials price is .73, and it is about one-fourth as great with respect to the wage rate. The difference between these elasticities is greater than one would expect from the composite DBS residential construction cost index, which has a ratio of materials/labour input of .625/.375. Variables representing demand/supply imbalance do not improve the fit of the equation.

This is not surprising, since the national accounts residential construction price series is based directly on cost data. The coefficient of variation is about 1%.

PINRC Price deflator for business investment in non-residential construction (Equation 7.7)

This equation is similar to the equation for PIRC, except that a different materials price index is used. Constrained quarterly variables multiplied by the wage rate are also used in order to pick up a small seasonal variance not evident in PIRC. The materials price index has about the same coefficients as the corresponding variable in the PIRC equation, but the wage variable in PINRC is much weaker, with a coefficient less than .1. The coefficient of variation is 1.23%.

PKIB Price of the nonfarm business inventory stock (Equation 7.8)

The national accounts implicit price deflator for inventory investment takes positive and negative values, large and small, because it is obtained as the ratio of the changes in current- and constant-dollar stocks. We therefore follow the same procedure in RDX2, calculating current- and constant-dollar inventory stocks separately. This requires us to explain PKIB, the price of the inventory stock. Our equation is straightforward, utilizing a four-quarter average of UGPPA/UGPPD, the Consumer Price Index (PCPI), and a time trend with a negative coefficient to offset some of the upward trend in PCPI. The coefficient of variation is .52%.

PRM Price index for residential construction materials (Equation 7.9)

PNRM Price index for non-residential construction materials (Equation 7.10)

The first step in explaining these prices is to purge them of their sales tax components. This purging process takes account of the estimate that 54% of the pre-tax materials expenditure for IRC is on taxable items. The corresponding proportion for non-residential construction materials is .46. A comparison of the two purged series and consultation with the weighting diagram used in their construction ([8] pp. viii-ix) shows that the composition of residential and non-residential construction materials is markedly different. Residential construction is characterized by a much higher proportion of lumber and lumber products (42.6% compared to 10.5% in non-residential construction materials) and a much lower proportion of more highly manufactured items. For example, plumbing and heating, electrical equipment, and metal products total 27.4% of residential construction materials compared to 56.7% of non-residential construction materials. Thus, although we tested symmetrical sets of specifications for the two equations, we were not surprised to find that the price of forest products exports had a much greater impact on the price of residential than of non-residential construction materials. Use of the export price for forest products is justified to the extent that foreign and domestic markets are both available to producers. Even those forest products that do not enter construction directly represent, to a degree, alternative uses for forest resources.

The available import price series did not aid in the explanation of either materials price index. We found that the degree of aggregate demand/supply imbalance (as measured by UGPPA/UGPPD) has a much larger influence on PRM than on PNRM.

The major difference between the two equations is that the price of residential construction materials depends on normal unit labour costs, whereas PNRM depends on both unit labour and unit capital costs. This difference is reasonable, since in non-residential construction greater use is made of highly manufactured materials. The elasticity of PNRM is about .54 with respect to unit labour costs and about .07 with respect to unit capital costs. The elasticity of PRM with respect to unit labour costs is about .90.

The fit of both equations is good, with coefficients of variation of .93% for residential and .55% for non-residential construction materials.

3 Government expenditure prices

In RDX2 we explain the separate prices for non-residential construction and machinery and equipment expenditure by governments, as well as an aggregate deflator for nonwage current expenditure (defined by using the wage rate as the price index for wage expenditure). At present the investment deflators (equation 7.18 and 7.19) are explained simply as linear functions of the corresponding deflators for private investment. Although these equations are adequate we hope to improve the specification

by taking account of the differences in the 'mix' of investment expenditure in the public and private sectors.

Government nonwage current expenditure comprises mainly services and nonwage defence expenditure. The deflator (PGCNWG, equation 7.17) is assumed to vary with the price of imports of manufactured products from the United States (PMMF12) and the price of consumer services (PCS). These prices enter the equation with six-quarter distributed lags, weighted respectively by the proportions of current defence expenditure (excluding military pay and allowances) and other nonwage current expenditure to total nonwage current expenditure.

C Foreign Trade Prices

In this section we discuss our specification of the equations for export and import price deflators. We explain two deflators for exports: one for the exports of all goods (except uranium, aircraft and parts, and motor vehicles and parts) to the United States (PXNMV12) and the other for exports of all goods (except uranium, aircraft and parts, and wheat) to other countries (PXNW13). The four import prices we explain correspond to the real flows modelled in equations 4.1 to 4.4 and described in section B of Chapter 4. At the moment price deflators for exports and imports of services, as well as price deflators for imports of goods from countries other than the United States, are exogenous in RDX2. As long as these prices remain exogenous it is necessary to make some adjustments in order to simulate

appropriately the consequences of a change in the price of foreign exchange (PFX). Some of the possible steps we might take are outlined in section A of Chapter 4.

1 Export deflators (Equations 7.11-7.12)

The price deflators for exports are estimated in level form and depend mainly on a weighted average of domestic prices, either U.S. or world prices, and the exchange rate. In equation 7.11 final demand deflators for consumption of goods (excluding motor vehicles) and investment in machinery and equipment are averaged with weights that reflect the export content of each final demand category. The price index for exports of forest products (PXFP) enters the equation independently. The elasticities of PXNMV12 with respect to domestic prices and PXFP are about .21 and .63, respectively. For the price of exports to third countries (equation 7.12) domestic final demand prices and PXFP are averaged with weights reflecting the relevant distribution of the export bundle to these countries. The elasticity of PXNW13 with respect to this average price is about 1.28.

PXNMV12 also depends on the price of U.S. nonfarm business product (PXBNF2) expressed in Canadian dollars, with an elasticity of about .19. Similarly, PXNW13 is influenced by the price index for world exports of goods (PWXG), increasing by .4% for every 1% increase in PWXG (with PFX constant).

Finally, current and lagged values of the exchange rate enter the equations for both export deflators. It is difficult

to know what coefficient to expect on PFX since the net effect of movements in the exchange rate will depend on the weighted average of the elasticities of demand for different components of exports as well as the relative proportion of exports priced in Canadian dollars. The estimated coefficients imply that with a 1% decrease in PFX, PXNMV12 will fall by .15% after four quarters have elapsed, whereas PXNW13 falls .31% immediately but then gradually increases, with the slightly anomalous result that the net effect of the decrease in PFX (a revaluation of the Canadian dollar) is to increase the price of exports to third countries by about .13%.

Both equations fit well, explaining 98% of the variance in PXNMV12 and 97% of the variance in PXNW13. The coefficients of variation for the two equations are .8% and 1.4%, respectively.

2 Import prices (Equations 7.13-7.16)

Each of the four prices of imports of goods from the United States is estimated as a four-quarter percentage change in the Canadian dollar import price divided by the exchange rate. The main independent variable in each equation is the four-quarter percentage change in an appropriately weighted average of U.S. prices. The exchange rate enters separately in equation 7.16 explaining the price index for imports of manufactures (PMMF12), and the negative coefficient indicates that over four quarters about 17% of any change in the exchange rate is offset by changes in the U.S. dollar price paid to U.S. producers.

On the whole the test statistics for equations 7.13-7.16 are disappointingly poor, although the values of the coefficients imply that the equations should perform reasonably well in simulation.

D Composite Price Indexes

In this section we discuss the Consumer Price Index, the aggregate national accounts implicit deflator for gross national expenditure (PGNE), and the implicit deflator for our private sector output variable (PGPP). We also refer briefly to the implicit price deflator for CSMVOD.

PCPI The Consumer Price Index (Equation 7.20)

This is a base-weighted index, so we explain it by a base-weighted sum of five national accounts deflators. The weights are determined by the shares of each of the national accounts categories in the basket of goods priced according to the CPI. The equation fits very closely, with a standard error of only .0026 on a 1961 base equal to 1. A significant negative constant term, and a coefficient of 1.09 on the synthetic PCPI, indicate that our national accounts categories are too aggregated to explain entirely the change in expenditure mix that has caused the Consumer Price Index to grow considerably faster than the GNE deflator over the last fifteen years. We have captured some of the seasonal change in the expenditure mix by including the constrained quarterly variables multiplied by the synthetic PCPI.

How well does our set of disaggregated price equations perform if account is taken of the inaccuracy in our equations for the prices of the PCPI components? To make an assessment, one must first re-estimate the PCPI equation over a shorter data period, matching the shortest data period used for any of the equations for the component prices. The standard error of the PCPI equation fitted 1Q58-4Q68 is .0024. If the equation is estimated over the same time period using the calculated rather than the actual values for PCNDSD, PCS, and the other consumer prices in PCPI, the standard error rises to .0040. Thus the errors in the equations for the component prices are not large enough to disturb the good fit of the PCPI equation.

PGNE Price deflator for gross national expenditure.
(Equation 7.21)

This price is determined within the model in the same way as it is defined in the national accounts, i.e. as the ratio of current-dollar to constant-dollar expenditure. We have equations in RDX2 for most of the constant-dollar expenditure components, and their current-dollar counterparts are obtained by multiplying each expenditure by its own price. (See equation 8.4.)

PGPP Price deflator for gross private business product
(Equation 7.22)

To obtain this price we first subtract from constant- and current-dollar gross national expenditure the constant- and current-dollar amounts representing value added by government,

agriculture, and noncommercial institutions. PGPP is then obtained, as is PGNE, by simple division.

PCSMVOD Implicit price deflator for imputed consumer services from the stocks of motor vehicles and of other consumer durables (Equation 7.23)

PCSMVOD is defined as the ratio of the current-dollar imputed income series to CSMVOD. The numerator of the ratio is determined by applying the rates of depreciation and opportunity cost used in equation 1.7 (for CSMVOD) to the replacement values of the relevant stocks and flows.

CHAPTER 8

THE OPERATIONS OF GOVERNMENTS

SECTORS 9-14

A Introduction

The government sectors of RDX2 contain equations explaining the major revenues and expenditures of the federal and provincial-municipal governments, as well as identities that indicate the financing implications of changes in the expenditure or asset accounts of the two levels of government. Our revenue equations have been constructed to include, wherever possible, explicit policy parameters as well as an accurate representation of the dynamic behaviour of the revenue item under consideration. Thus, for most of our tax equations we regress actual collections on a synthetic collections series that is derived by multiplying a weighted average rate by an appropriate base and that is then adjusted to reflect payment or recording lags or both. Specification of tax equations in this manner has two advantages. First, in constructing our synthetic tax series, we can take account of the essential complexities of the tax structure; this allows us to indicate explicitly the relevant policy parameters. Second, the criterion of an appropriate specification is very simple - the estimated coefficient should not be significantly different from 1. Thus the coefficients can be used to assess

the accuracy with which we have captured the relevant features of the tax.

The expenditure equations we present are of two types: transfers to persons and both current and capital expenditure on goods and services. To construct the former we follow the procedure employed for the revenue equations, using our knowledge of the relevant legislation and introducing the rates of transfer payments as policy parameters. For goods and services expenditure, however, we have no hope of duplicating the tight analytical structure of the tax and transfer equations. In general we assume that such expenditure responds to the demand for government services and, where appropriate, to relative prices, credit conditions and variables that can be viewed as representing targets of stabilization policy. Such equations are useful for forecasting expenditure in the absence of policy changes or for indicating the induced effects of changes in tax or transfer rates on government expenditure, but they contain no explicit policy parameters. Thus alternative policies can be easily assessed only when one has, or assumes, some a priori knowledge of their future effects on different categories of goods and services expenditure.

In the remainder of this chapter a brief explanation is provided of the equations presented in Sectors 9-14. The reader is referred to [28] and to a forthcoming study [22] for a discussion of the specifications adopted, alternatives that might be considered, sources of data used to create many of the policy parameters, and suggestions for forecasting the exogenous variables.

B Revenue Equations (Sectors 9-10)

1 Personal income tax collections (Equations 9.1-9.29)

In modelling personal income tax collections we distinguish between assessed wage income (YWAS) and assessed nonwage income (YNWAS) since these types of income fluctuate differently, are taxed at differing effective rates and are characterized by different lags between the accrual of tax liability and the payment of tax. Because taxes on wage income (TPS) are deducted at source, a one-month lag generally occurs between the accrual of tax and its collection. Nonwage income recipients assess themselves and pay their tax (TPO) in quarterly instalments. Annual values for YWAS and YNWAS are linked to corresponding series in the national accounts by means of annual regressions estimated from 1950 to 1968. We then define the quarterly series for YWAS and for YNWAS in equations 9.8 and 9.9 by applying the estimated coefficients from the annual regressions to the quarterly values of the independent variables. A similar procedure is employed to generate a quarterly series for NT (equation 9.7), the number of tax returns filed.

Exogenous spreading ratios (equations 9.10-9.21) are used to allocate YWAS, YNWAS and NT to four broad income classes, based on assessed income (under \$3,000; \$3,000-\$5,000; \$5,000-\$10,000 and over \$10,000). We calculate separate weighted average tax rates for each of these classes, a procedure enabling us to capture the degree of progressivity in the rate structure in an appropriate way. The assumption that, in each income class,

average assessed wage income equals average assessed nonwage income allows us to split the number of filed tax returns into wage and nonwage categories (equations 9.22-9.29). In each income class, for each of the categories of income, the number of tax returns is multiplied by the average level of exemptions and deductions (an exogenous variable depending on a set of policy parameters and the distribution of demographic characteristics among income classes), and the result is subtracted from assessed income to get taxable income. Sets of weighted average tax rates representing total federal tax, 'basic tax' and provincial surtaxes are applied to taxable income, and the results are summed across income classes to get tax accruals on wage income (TAW, equation 9.5) and on nonwage income (TANW, equation 9.6). In addition TANW is adjusted to take account of the dividend tax credit. Stochastic equations then link TPS (equation 9.1) to TAW, and TPO (equation 9.2) to TANW.

The provincial portion of the personal income tax is explained in equation 9.3. Provincial tax is calculated by applying provincial rates to the federal 'basic tax'. The federal government collects the tax on behalf of all provinces except Quebec and then remits the provincial shares. Therefore we assume a two-month lag between accruals and collections for all provinces but Quebec and a one-month lag for Quebec. Finally, having determined TPS, TPO and TPYPM, the federal share of the tax (TPYF) is given as a residual (equation 9.4).

Although the income tax submodel is complex it enables one to estimate quickly the effects of changes in relative shares, income distribution, 'basic tax' rates, federal tax rates,

abatements to provinces, provincial surtaxes, exemption levels, or the rate of dividend tax credit.

2 Corporation tax accruals (Equations 9.33-9.36)

Total corporation tax accruals net of provincial logging and mining taxes (equation 9.33) are estimated as a function of a weighted marginal tax rate, taxable corporate profits and a qualitative dummy variable designed to correct the overstatement of tax liabilities due to the use of a weighted marginal rather than a weighted average tax rate. Federal corporation income tax accruals (equation 9.35) are determined in a similar manner and provincial corporation income tax accruals are given residually (equation 9.36). Taxable corporate profits (YCT, equation 9.34) are estimated as a function of national accounts profits (net of YPCCB and TCAPLMT) with adjustments for losses approximated by cyclical and trend variables. Qualitative dummy variables are used to measure the effects on YCT of accelerations (ECCA63A) and reductions (ECCA66R) in capital consumption allowances for tax purposes.

3 Transfers from persons to provincial-municipal governments (Equations 9.30-9.32)

Hospital and medical care insurance premiums (TRHPMPR) are estimated simply as a function of a weighted average hospital insurance premium rate multiplied by the labour force, with the addition of a term representing medical care insurance premiums,

which were introduced in 3Q68. This estimation extends to the end of 1969, since the variable created to capture medicare premiums was insignificant when the estimation period was constrained to end in 4Q68. The personal share of motor vehicle licences and permits (TRMVPMPR) depends on a weighted average rate of licence fee for noncommercial motor vehicles, and on the number of vehicles (UKRMVNC). UKRMVNC is defined quarterly, using the coefficients from an annual regression on the constant-dollar stock of motor vehicles and parts (KMV), with the unemployment rate added to capture cyclical variation in scrappage rates.

4 Indirect taxes and other government revenue (Equations 10.1-10.7)

With the exception of excise taxes and duties (TIEXF), customs duties (TICUSF), and the witholding tax (TWF), the indirect tax equations presented in Sector 10 depend on weighted average tax rates and variables chosen to represent the appropriate base. Thus in the equation for the manufacturers sales tax (TISF, equation 10.1) the general sales tax rate (RTISF) is applied to consumer expenditure on goods, and the rates of tax on building materials (RTISFR) and on production machinery and equipment (RTISFME) are applied to investment in non-residential and residential construction, and to investment in machinery and equipment, respectively. The actual rate applied to investment in non-residential construction is .46 RTISFR/(100+.46 RTISFR), since only 46% of pre-tax INRC is

subject to tax. Similarly the rate applicable to residential construction expenditure is adjusted to reflect the fact that only 54% of that expenditure (net of tax) is taxable. RTISFME applies only to production machinery and equipment (about 88% of the total) and the remainder is subject to the general sales tax rate. The coefficient on the first term in equation 10.1 should be less than 1 since the federal sales tax is levied on the manufacturer's sale price whereas consumer expenditure on goods includes federal and provincial-municipal sales taxes as well as the retailer's margin. The low coefficient on the second term may be due to an overestimate of the proportion of taxable investment expenditure as well as to the assumption that this proportion is identical for public and private investment.

The retail sales tax (TISPM, equation 10.4) is a function of the weighted average retail sales tax rate and consumer expenditure on goods, deflated by 1+.01 RTISPM to put it on a pre-tax basis. The coefficient indicates that receipts from taxes on services and on sales of secondhand goods more than outweigh the effect of exempt items included in consumer expenditure on goods.

The gasoline tax (TIGASPM), modelled in equation 10.5, depends on weighted average tax rates for gasoline and diesel oil, exogenous ratios indicating the number of gallons of gasoline per noncommercial vehicle (EGAS), the number of gallons of diesel oil per commercial vehicle (EDO) and the stocks of noncommercial and commercial motor vehicles. The stock of commercial motor vehicles is proportional to KME and appears

throughout the model in the form .00009392 KME. This relationship is based on the annual regression results described in [22].

The business share of motor vehicle licences and permits (equation 10.6) is estimated as a function of the stock of commercial motor vehicles and a weighted average rate of licence fee applicable to such vehicles.

Federal customs duties (equation 10.2) are a function of imports of goods expressed in current dollars with dummy variables to reflect the imposition of surcharges in 1962-1963, the duty-remission programme of 1964, the Canada-United States Automotive Agreement and the Kennedy Round of tariff reductions. A time trend captures the general reduction in tariffs over the estimation period as well as any substitution of untaxed or relatively lightly taxed items for goods subject to higher tariffs in the import mix. The estimated coefficients indicate that, after full implementation, the Kennedy Round will result in tariff reductions of about 20%.

Excise taxes (other than the manufacturers sales tax) and excise duties are a simple function of consumer expenditure on goods, with a dummy variable to capture the removal of the excise tax from automobiles in 2Q61.

Finally, the non-resident withholding tax (equation 10.7) is estimated as a function of dividend payments to the United States (MDIV$12), interest payments to the United States (MINT$12), and interest and dividend payments to other countries (MID$13), all measured net of the tax. These three variables have been added together in the equation and the coefficient implies an effective tax rate of 16.79%. This is somewhat higher than the average

effective statutory rate (about 12% in 1965), presumably because we have understated the true tax base by omitting such items as royalties, management fees, etc.

C Expenditure Equations (Sectors 11-13)

1 Transfers to persons (Equations 11.1-11.6)

Five of the six equations in Sector 11 are devoted to explaining the operation of the Unemployment Insurance Fund. The number of persons enrolled in the fund (NINS, equation 11.3) is related to paid nonfarm employment and the number of persons unemployed, with dummy variables to capture the increase in coverage in 3Q68 and the extension of coverage to agricultural workers in 2Q67. The decline in the number enrolled, as a proportion of paid nonfarm employment, is due partly to increasing per capita income (which reduces the proportion of employed persons eligible for coverage) and partly to structural shifts in the labour force between covered and uncovered occupations. For example, expansion of the health and education industries in which most employees are uninsured reduces proportional coverage. Equation 11.4, in which the number of claimants (NCL) is explained, depends on the level of enrolment in the fund and the number unemployed. In equation 11.6 we determine the number of employed contributors (NEMPS) residually, and in turn use this figure to explain the flow of contributions into the fund (TUIRF, equation 11.1). Benefit payments (GTPUIBF)

are explained in equation 11.2 by the number of claimants and a weighted maximum benefit rate (ERUIB), which is an explicit policy variable.

In equation 11.5 we explain the portion of interest payments on the federal public debt that remains after excluding such payments as interest on pension funds, on nonmarket issues held in government accounts, and on Bank of Canada holdings of federal debt. These excluded payments (EIFDMIS) in 1968 amounted to about 35.5% of total federal interest payments. The remaining payments are explained by the end-of-quarter stocks of Government of Canada direct market issues (LGBF), treasury bills (LGFTB), and Canada Savings Bonds (LGFCSB), each weighted by an appropriate coupon rate to develop a synthetic interest series.

2 Current expenditure on goods and services (Sectors 12-13)

This expenditure is disaggregated into wage and nonwage categories and the wage expenditure is further divided into employment and wage rate equations. Explanations of wage rates and employment are given separately for federal and provincial-municipal public administration and defence (exclusive of military pay and allowances) categories, as well as for elementary and secondary schools under municipal control.

2.1 Federal expenditure (Equations 12.1-12.3)

Demand for labour by the federal government is estimated in ratio form, with employment per capita (NGPAF/NPOPT) responding

to real personal income, relative prices, total population and the unemployment rate.

The relative price term is defined as a ratio of the price of labour (an index of the quarterly wage rate including supplements, with 1961=1) to the price of government nonwage current expenditure (PGCNWG). Although we expect a part of nonwage current expenditure to be complementary to employment the substitution effect appears to dominate, as the relative price term enters with a negative sign and a t-value of 7.8. Employment per capita adjusts to a change in relative prices over a period of four quarters, with an equilibrium elasticity of about -.6 (evaluated at the sample means).

The level of employment per capita also responds to changes in the demand for government services, reflected by real personal income and population. Although the pattern of adjustment is identical for both these variables, employment responds more rapidly to changes in real personal income than to changes in population (three years as opposed to five years). The equilibrium elasticities of employment per capita with respect to YP/PCPI and NPOPT are 1.07 and -1.79, respectively. Thus, if population increases by 1% with real per capita income constant, the level of employment will increase by .28%. The response of employment to changes in real per capita income varies directly with the change in population. For example, if per capita income increases by 1% with a 1% increase in population, NGPAF will increase by about 1.35%. A similar increase in per capita income with a 2% increase in population implies an increase of about 1.63% in NGPAF. Finally the level of the unemployment rate

affects NGPAF, indicating policymakers' responses to variations in an important target of stabilization policy.

The federal government quarterly wage rate (WQGPAF) is assumed to respond to the average level of wages in the rest of the economy (WQAXF). In equation 12.2, estimated in logarithmic form, the indication is that WQGPAF adjusts to WQAXF over an eight-quarter period with an equilibrium elasticity of about 1.10. The magnitude and speed of response vary seasonally, as well as with current and past conditions in the labour market.

The federal wage rate and employment equations perform reasonably well. A regression (1Q57-4Q68) of the actual wage bill on the calculated wage bill has an estimated coefficient not significantly different from 1.0, an RB2 of .98 and a standard error of $7.3 million (or 2.4% of the average quarterly value of the wage bill in 1968).

Our explanation of federal current nonwage expenditure (GCNWF, equation 12.3) has some satisfactory features, although the strongly significant time trend makes the specification suspect. Ideally, we should like to define our dependent variable net of capital consumption allowances (CCAGF$) and defence nonwage expenditure, both of which are included in GCNWF in the national accounts. We have not yet been able to obtain a data series for defence nonwage expenditure and we suspect that, throughout our estimation period, the downward trend in the dependent variable was due to a rapid decline in this category of expenditure. GCNWF does respond positively to changes in real personal income, but the magnitude of the response seems extremely strong with the equilibrium elasticity approaching 4.0.

Although we suspect that the coefficients on YP/PCPI and QTIME are both too large because of the high simple correlation between them (.97), attempts to respecify the equation to reduce the collinearity were not successful. Looking at the brighter side, however, the equation does explain almost 90% of the variance in nonwage current expenditure; and the relative price term, which performed so well in the NGPAF equation, enters here also, this time with an equilibrium elasticity of a little over -.5. In addition GCNWF responds quickly, and fairly strongly, to changes in the unemployment rate and to expected rates of price change (PCPICE). The elasticities of GCNWF with respect to these targets of stabilization policy are .41 and -.22, respectively. Although the equation will probably serve for short-run forecasting purposes it may well produce curious results in policy simulations. And since this category of expenditure is relatively large (the mean quarterly value of the dependent variable over the period from 1Q58-4Q68 is $238.3 million) it may be better left exogenous for many of our experiments.

2.2 Provincial-municipal expenditure (Equations 13.1-13.4)

Over 99% of the variance in provincial-municipal employment (NGPAPM, equation 13.1) is explained by real personal income, relative prices, credit conditions, and a variable constructed to reflect the budget constraint facing provincial-municipal governments. Recent studies of state and local government expenditure in the United States have emphasized this constraint and attempted to model it by including an appropriate income

variable, adjusted to represent a revenue base, in their econometric specifications [5] [24]. The coefficient on this variable is interpreted as reflecting a compromise between the level of services demanded and the level of services public officials think it possible to supply with a given revenue base. One problem with this type of approach is that the relationships between total revenue and the revenue base are not explicitly spelled out, and so it is not possible to simulate directly the effects on expenditure of a change in the budget constraint due to changes in tax rates. Since for RDX2 we have developed detailed equations relating different revenues to appropriate tax rates and bases, we attempted to use this information to construct a variable that would capture the budget constraint confronting provincial-municipal governments. The variable we chose, defined as (YTOTPM+GBCPPPM)/(YTOTPM-GBALPM+GALPM), represents the proportion of total (national accounts and nonnational accounts) expenditure that can be financed without recourse to the capital market. The elasticity of NGPAPM is about .2 with respect to this variable and about 1.1 with respect to real personal income. In addition credit conditions, represented by (RABEL-RABELD)/RABEL and RL, affect the demand for labour. The elasticity of NGPAPM with respect to the long-term interest rate is about -.08, whereas a 1% increase in (RABEL-RABELD)/RABEL, which is the variable we use to measure the availability of credit, increases the level of employment by about .03%. Finally, as was the case with NGPAF, we found that the demand for labour by provincial-municipal governments was sensitive to relative prices. In virtually all the speci-

fications tested the relative price term (defined analogously to that used in equation 12.1) was strongly significant and the price elasticity of NGPAPM never varied much from -.5.

Equation 13.2, which is used to explain the average quarterly wage rate (WQGPAPM), is similar in structure to equation 12.2. A regression of the actual wage bill on the wage bill calculated from equations 13.1 and 13.2 over the period 1Q58-4Q68 has a coefficient not significantly different from 1.0, an RB2 of .99 and a standard error of $5.9 million (or 1.7% of the average value of the wage bill in 1968).

Provincial-municipal current nonwage expenditure (GCNWPM), net of capital consumption allowances and medical care insurance payments (equation 13.4), is explained primarily by real personal income and relative prices. The elasticity of GCNWPM with respect to relative prices is about -.43, whereas the response to changes in personal income depends on the borrowing requirements of the provinces and municipalities relative to their mean borrowing requirements over the estimation period. If current borrowing requirements equal their average level then a 1% increase in YP/PCPI will lead to a .5% increase in GCNWPM over four quarters. The change in the seasonal pattern, represented by the interaction of constrained quarterly dummies with QDSEAS, is due to differing seasonal patterns in the provincial and municipal series and the relative predominance of provincial expenditure in the total after 1965. QDCENT is a dummy variable equal to 1.0 in the period 3Q66-2Q67 and zero elsewhere. The rationale for the inclusion of QDCENT is not clear, although the usefulness of the variable is obvious. In the four quarters in

which QDCENT takes nonzero values, GCNWPM was about 45% higher than in the previous four quarters and about 20% higher than in the following four quarters. Since GCNWPM is calculated as a residual it is virtually impossible to explain why this bulge should have occurred, but we suspect that the increased expenditure may have been related to Canadian centennial celebrations, particularly to an acceleration in repairs to the provincial and municipal infrastructure. The effect of QDCENT is to increase GCNWPM over the period from 3Q66-2Q67 by about $248 million, or 27.5% of what it otherwise would have been.

Equation 13.3 explaining employment in elementary and secondary schools under municipal control (NIS) is straightforward. The teacher/student ratio depends on real per capita personal income, the number of students, the change in the number of students, the long-term interest rate, and the level of provincial grants per student to municipal governments. Equilibrium elasticities of the ratio with respect to the income and grants variables are .20 and .11, respectively. The interaction of the coefficients on JW(NPOPS) and JW[J1D(NPOPS)] implies that a 1% increase in the number of students enrolled will cause NIS to increase by .1% in the current quarter and by about .07% in each of the succeeding twelve quarters. Thus in equilibrium the elasticity of NIS with respect to NPOPS is about .95, implying a slight increase in the student/teacher ratio with per capita income and grants per student held constant. Finally, the long-term interest rate enters significantly and with the appropriate sign; the interest elasticity of school employment is quite low (about -.04 spread over eight quarters).

Attempts to explain the quarterly wage rate corresponding to NIS were unsuccessful so we have decided to leave WQISM exogenous for the time being.

3 Capital expenditure on goods and services (Equations 12.4, 13.5, 13.6)

The recent major revision of the national accounts [10] provides consistent quarterly time series for fixed capital formation by governments. We have used this information to develop equations explaining investment in non-residential construction by the federal and provincial-municipal governments, disaggregating the latter expenditure category into expenditure on construction of elementary and secondary schools under municipal control (INRCSM) and on other non-residential construction by provincial-municipal governments (INRCGPM). Some attention was devoted to modelling machinery and equipment expenditures, but, in view of the relatively small amounts of money involved and the large number of coefficients in the preferred structural equations, it was decided to leave these categories exogenous to RDX2. However, some equations for government investment in machinery and equipment will be reported in [22].

The basic model we use to explain government investment is a flexible accelerator model of the type employed in RDX1 [18]. Current net investment is assumed to depend on present and past values of a gap between desired and actual capital stock. Variables designed to capture the reaction of investment to

variations in policy targets or credit conditions enter linearly. These variables are specified in index form so that they affect the dynamic response of investment but in equilibrium become effectively absorbed in the constant term.

Equation 12.4, in which we explain federal investment in non-residential construction (INRCGF), is estimated in per capita form. Real per capita personal income and population determine the desired per capita stock of non-residential construction. The estimated weights on these variables are convolutions of three separate weighting patterns representing the way in which past values of the variables affect the desired capital stock, the extent to which a given value of the gap results in a decision to invest (which is assumed to depend on the relation between past and current values of the gap), and the response of investment outlays to a given decision to invest. The estimated coefficients imply that in equilibrium the elasticity of the capital stock is about .63 with respect to real personal income and about .36 with respect to population. Current and lagged values of the ratio of a four-quarter average of the unemployment rate to a twelve-quarter average of the unemployment rate enter the equation with positive coefficients, indicating that the response to a given gap will be greater when the current value of the unemployment rate is high relative to past values.

Equation 13.6 in which we explain INRCSM is similar to equation 12.4. The equilibrium elasticity of the stock of schools is about .90 with respect to real personal income and about 1.66 with respect to the number of students. The pattern of response to a gap between the desired and the actual stock of

schools is affected by the level of grants from provinces to municipalities.

For the nonschool investment of provincial-municipal governments (INRCGPM) we were unable to develop a satisfactory specification that included the effects of the lagged stock. We finally chose a simple accelerator model, based on the assumption that the stock of capital provided by provinces and municipalities is in part complementary to the stock of all other residential and non-residential construction and in part dependent on the level of real final demand exclusive of changes in this stock. The short-run response of INRCGPM is affected by the budget constraint of provincial-municipal governments as well as the real long-term interest rate. But again we have specified these variables in index form so that in equilibrium gross investment varies only in response to changes in the stock of other residential and non-residential construction, with an elasticity of about .43.

D Changes in Government Asset and Liability Accounts (Sector 14)

When specifying the transactions of the public sector it is important to make the links between expenditure, taxation and the pattern of government financing as explicit as possible. Only when these links have been adequately specified is it possible to take proper account of the interdependent nature of fiscal and monetary policies, and the portfolio effects of different policy

choices. Sector 14 contains a number of accounting identities that describe these links as well as some supporting stochastic equations.

In equations 14.6-14.8 we define the net national accounts position of the federal government, the provincial-municipal governments, and hospitals, respectively. Equation 14.9 is the identity equating total sources and uses of funds for the federal government. Any net use of funds not financed by an increase in Government of Canada direct market issues (LGBF) or a decrease in government cash balances (DDGFB) will lead to an automatic increase in the stock of treasury bills. The difference between corporation taxes accrued and collected, which is an important use of funds, is determined endogenously, since TCCF is explained in equation 14.1. The specification of this equation is intended to capture actual payment practices as set out in the relevant legislation and is described in some detail in [28], pp.72-80. GAMIS, which is an exogenous variable defined residually by equation 14.9, represents net changes in federal asset accounts excluding advances to the Foreign Exchange Fund. We intend to disaggregate GAMIS to a greater degree as it becomes worthwhile to focus on changes in particular asset accounts, either by explaining them stochastically or using them in the explanation of other relationships or (hopefully) both.

The gross borrowing requirements of provincial-municipal governments (GBRPM), as defined in equation 14.11, are used in equation 14.12 to determine the stock of direct and guaranteed bonds outstanding. We weight the resident-held stock of all government bonds by a market-valuation ratio (PLGI, equation

14.10) and the resulting market value (VLGB11) enters the private sector wealth variable. (See equations 18.3 and 18.4.) As well as adding directly to the stock of wealth, VLGB11 is used in the creation of our series for permanent nonwage disposable income (YPDNWP) and revaluation gains and losses (YKGP), which directly influence consumption behaviour.

PLGI is a weighted average of federal and provincial-municipal valuation ratios, which are themselves weighted averages of stochastically determined valuation ratios for each of the four maturity classes of Government of Canada direct market issues (equations 14.2-14.5). PLGF1C, PLGF2C, PLGF3C and PLGF4C are weighted by the proportion of total resident-held Government of Canada direct market issues in each maturity class, and the results are summed to get an aggregate federal valuation ratio. This ratio is then scaled by EWLF, which represents the proportion of resident-held Government of Canada direct market issues to all government bonds held by residents. Since no breakdown of the maturity structure is available for provincial and municipal bonds we assume that such bonds are issued at regular intervals with an initial term to maturity of fifteen years. This assumption gives rise to the constants used to weight PLGF1C, PLGF2C, PLGF3C and PLGF4C in equation 14.10. We then scale the provincial-municipal valuation ratio by 1-EWLF in order to calculate PLGI.

Finally we should comment on the specification of the four valuation ratios modelled in equations 14.2-14.5. The data source for the valuation ratios is an issue-by-issue analysis of Government of Canada direct market issues outstanding at quarter

end from 1955 forward. However, rather than attempt to relate these price indices to interest rates in a general way, we used the same data to derive weighted average coupon rates and term-to-maturity variables for the four maturity classes. Given this information and market yields generated elsewhere in RDX2, we used the general formula for the present value of a bond with semiannual coupon payments to generate synthetic price series. These series were then used as regressors in our valuation equations. Evaluated at the sample means, the elasticities of PLGF1C, PLGF2C, PLGF3C, and PLGF4C with respect to the relevant interest rates are -.05, -.16, -.29 and -.60, respectively.

CHAPTER 9

THE FINANCIAL SECTOR

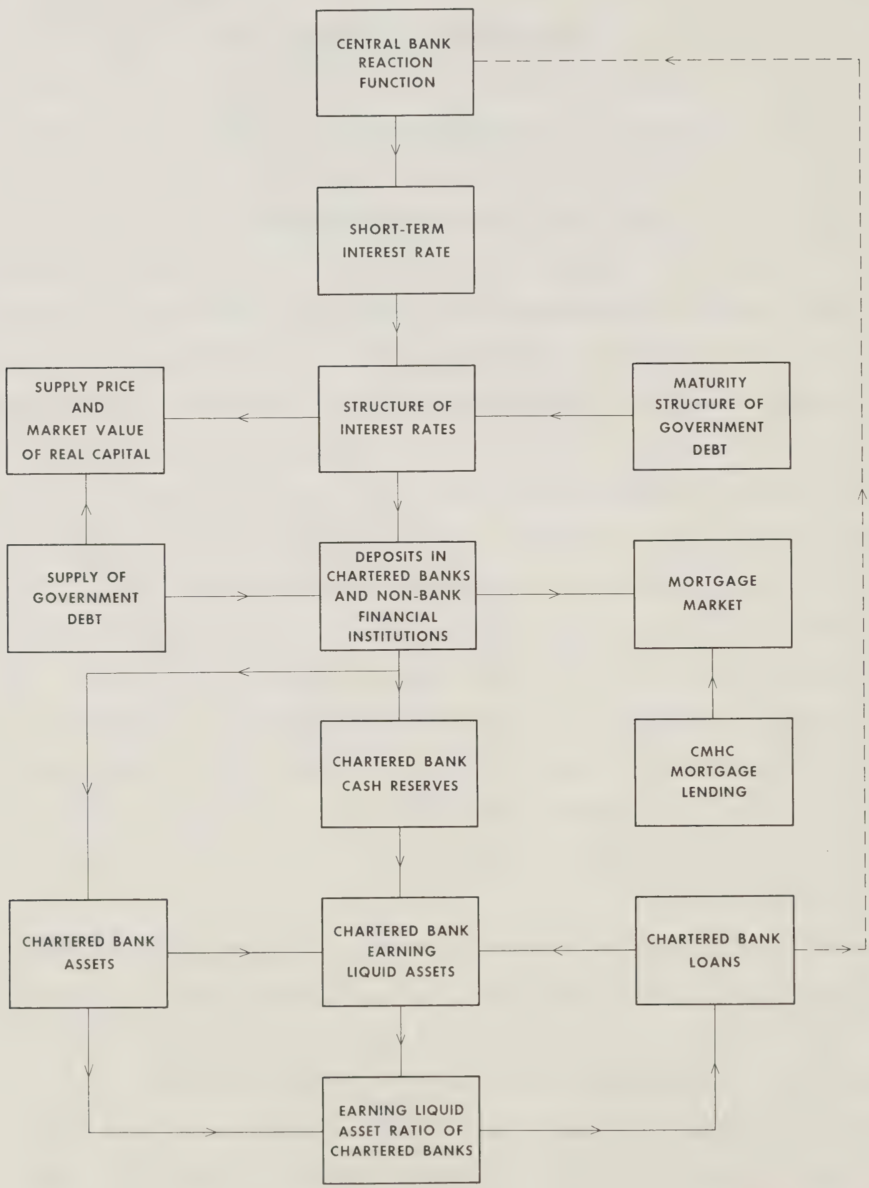
SECTORS 15-18

A General Outline

The basic structure of the financial sector is outlined in the flow chart below. This structure differs in three respects from that of a more conventional model in which the short-term interest rate is determined by the interaction of a money demand function with an exogenously determined money supply or monetary base. First, the interest rate is treated as the primary target of monetary policy and is determined by a central bank reaction function. Second, an attempt is made to approximate empirically the cost of capital or the supply price of capital as an important determinant of investment behaviour. Third, the role of the equations for bank assets and liabilities in the model is primarily to determine the ratio of earning liquid assets to total bank assets, which is then used as a measure of credit availability.

As indicated by the flow chart, the structure of the model is almost recursive. The short-term interest rate, determined by the reaction function described in section C below, feeds into the market reduced-form equations for other interest rates in the model described in section E and determines the demand for chartered bank liabilities, real capital assets, and the

FLOW CHART OF THE FINANCIAL SECTOR



liabilities of non-bank financial institutions. The demand functions for financial assets are treated in the context of a portfolio model estimated simultaneously and subject to consistency constraints on the coefficients, as discussed in section B. In view of the wide variance in the market value of real capital, the market for this asset is specified as a reduced-form equation (outlined in Section F) outside the general portfolio model.

The demand for bank liabilities determines the size of total bank assets and the volume of cash reserves that must be supplied to achieve the interest rate target. These variables in turn, together with the demand for bank loans, determine the quantity of earning liquid assets and the earning liquid asset ratio (RABEL). This latter variable feeds back into the demand for bank loans. In addition, the rate of growth of bank loans is assumed to influence the central bank's interest rate target and therefore feeds back to the reaction function. This set of equations is discussed in section D.

An additional link with the real sector is provided by the demand for deposits in non-bank financial institutions, which feeds into the mortgage market. This is discussed in section G.

B The Demand for Liquid Assets

1 Scope and specification of the model

The financial sector of RDX2 includes demand functions for eight categories of liquid asset holdings of the private domestic nonfinancial sector. These categories include currency, four types of chartered bank deposits, two types of trust and loan company deposits, and Canada Savings Bonds. There is in addition an implicit demand function for a residual category defined as holdings of Government of Canada treasury bills and bonds, and provincial and municipal bonds less chartered bank day-to-day, call and short loans (ANFGN).

Our basic hypothesis is that the proportion of total liquid assets (A) held in each category [A(i)] depends on the rates of return [R(i)] and the ratio of income (Y) to total assets. Thus we assume:

$$A(i)/A = a(i) + b(i)Y/A + \sum_{j=1}^{9} c(i,j)R(j)$$

$$i = 1, 2, \ldots, 9$$

The income variable is included to represent the effect of transactions requirements on the choice of assets, given differences in transactions costs. These costs involve such things as service charges on chequing accounts, loss of interest on deposits that require a minimum holding period, and the cost in terms of inconvenience of shifting from an asset that does not

serve as a medium of exchange to one that does in order to satisfy requirements for transactions balances. Thus, the higher is income relative to total asset holdings, the higher will be the proportion of assets held in a form that involves a low cost of transactions. The implication is that the income variable will have a negative effect on the demand for less liquid assets.

2 Constrained estimation procedure

Since the above demand functions are specified in the form of ratios of each category to total liquid assets, constraints must be imposed on the coefficients to preserve the identity relating the total to the sum of the components. For example, any changes in rates of return may cause a shift in asset choice, but the effects must sum to zero over the whole portfolio. Similarly, a change in total wealth must be distributed over the portfolio so that the effects sum to unity. Since the dependent variables are in the form of ratios to total assets, this latter constraint applies to the constant terms.

If the parameters in each equation are estimated by least squares these constraints will be automatically satisfied provided that the same set of explanatory variables is used in each equation. If, however, some coefficients are set equal to zero (as would be the case, for example, if some asset pairs are not substitutes), the constraints must be incorporated into the estimation procedure. This may be done in the following manner. One first chooses a residual equation the coefficients of which will not be estimated directly, but will be determined by

applying the constraints. The remaining equations will then be estimated simultaneously subject to the constraint that the coefficients for any variable excluded from the residual equation must sum to zero. The joint estimation is carried out using a two-stage procedure suggested by Zellner [55] that allows for different residual variances for different assets as well as contemporaneous correlations between residuals in different asset equations.

3 Portfolio constraints in lagged adjustment models

The most convenient device for modifying the above model to allow for lagged responses to changes in the explanatory variables is the familiar stock-adjustment model. This approach leads to the inclusion of the lagged value of the dependent variable in each equation with coefficients interpreted as 1 minus the speed of adjustment. However, this formulation cannot be used directly in a portfolio context since the presence of each lagged dependent variable in only one equation prevents the imposition of consistency constraints across the portfolio. In fact, the simple stock-adjustment model is not consistent with a portfolio approach since it fails to account for the interaction between disequilibria in various asset holdings in a consistent way.

A modified stock-adjustment model that maintains consistency is given by the following formulation:

$$A(i)/A = a(i) + b(i)Y/A + \sum_{j=1}^{9} c(i,j)R(j)$$

$$+ (1-d)J1L[A(i)]/A + e(i)J1D(A)/A$$

A common speed of adjustment, d, is assumed for all assets and the change in total assets is included as an additional variable. This term can be interpreted as providing for an inertia effect with the coefficients e(i) determining the temporary allocation of an increase in total assets while the stock-adjustment process works itself out.

An alternative form of the model, which is convenient for constrained estimation, is given by the following equation:

$$A(i)/A = [a(i)+e(i)] + b(i)Y/A + \sum_{j=1}^{9} c(i,j)R(j)$$

$$+ (1-d)J1L[A(i)]/A - e(i)J1L(A)/A$$

Consistency is then achieved by the additional constraint that the coefficients e(i) sum to 1-d.

4 Empirical results (Equations 15.1-15.8)

For purposes of estimation the above model was modified as follows. First, dummy variables were added to allow for seasonality and other identifiable non-numeric factors. A dummy variable (QDB) with a value of unity from 1Q62 forward was

employed to allow for the introduction of foreign currency swapped deposits and for some changes in chartered bank policy regarding nonpersonal term and notice deposits. Similarly, the variable QDBA, with a value of unity from 3Q67 forward, was introduced to represent the effect of the 1967 Bank Act revision, under which the interest rate ceiling on bank lending was removed. Second, we allowed for portfolio scale effects by including the reciprocal of total assets as an additional variable. The third modification was prompted by the low speeds of adjustment that were obtained when the model outlined above was fitted. To allow for the possibility of a faster speed of adjustment for demand deposits (DDB), the lagged stock of this asset was included in the equations for demand deposits and implicitly in the equation for the residual asset. Similarly, a different reaction lag for currency is permitted by including the lagged stock in the equations for currency (ANFCUR) and for chartered bank personal deposits (DPB). A significant result was obtained only in the case of currency. The coefficients imply a speed of adjustment for ANFCUR of 72% per quarter compared with 30% for the others.

In view of the problem of multicollinearity among interest rates, the range of possible substitution effects was narrowed down by dividing the assets into two groups with zero cross-elasticities between assets not in the same group. The first group of assets (equations 15.1-15.4) is held primarily by households that have relatively small portfolios, whereas the second group (equations 15.5-15.8) comprises assets held primarily by businesses or by households that have relatively

large financial portfolios. Substitutability was permitted between the government securities variable (ANFGN) and assets in both groups. Within the first group significant substitution effects were obtained between personal savings and chequing deposits in chartered banks (DPB) and each of the other three assets, i.e. currency (ANFCUR), savings deposits in trust and loan companies (DSTL), and Canada Savings Bonds (LGFCSB). The government securities asset was found to be a substitute for each of the three categories of Canadian dollar deposits in chartered banks, i.e. personal deposits (DPB), demand deposits (DDB), and nonpersonal term and notice deposits (DNPTB), as well as term deposits in trust and loan companies (DTTL). In addition a significant substitution effect was obtained between DNPTB and foreign currency swapped deposits in chartered banks (DSWPB). In this case an additional constraint was imposed by entering the interest rates in the form of a differential. A shift in the substitution relationship between DNPTB and ANFGN was allowed for by including the relevant rate differential interacted with QDB.

In the equations for currency and bank deposits the coefficients on income are positive while income has a negative effect on ANFGN. This indicates that the proportions of these assets shift in response to transactions requirements as hypothesized above. The results for the inertia effect represented by lagged total assets were, however, somewhat puzzling. The only sizeable coefficient appeared in the ANFGN equation rather than in the currency and bank deposit equations where one would have expected the inertia effect to be concentrated. In the equations shown, coefficents more

consistent with this a priori view were obtained by excluding lagged total assets from the ANFGN equation.

C The Reaction Function of the Central Bank

1 Choice of the monetary policy instrument

The choice of a variable to be treated as an exogenous monetary policy instrument is complicated by conflicting criteria of selection. First, to be suitable for policy simulation, the variable must be controllable by the monetary authority. Second, the use of historical data to measure the response of the variable to policy changes requires that the variable was in fact consistently viewed as an instrument by the monetary authority over the period under consideration. Third, in order to identify behavioural parameters statistically (in the econometric sense) the exogenous policy variable must be truly exogenous in the sense that it is not systematically influenced by endogenous variables.

Based on the criterion of controllability, most existing models use bank reserves or the monetary base (bank reserves plus currency outside banks) as the policy instrument. In the Canadian institutional setting, a more appropriate choice appears to be chartered bank excess cash reserves or the ratio of excess cash to statutory deposits. Since required reserves are based on statutory deposits, defined as Canadian dollar deposit liabilities averaged over consecutive Wednesdays ending with the

second last Wednesday of the preceding month, control of total reserves implies control of excess reserves. Given the predictability of currency drains and other factors affecting the reserve base, the central bank can be viewed as exercising close control over the excess cash ratio.

In our view, the interaction of the excess cash supplied by the central bank with the level of cash desired by the chartered banks represents a key element in the short-run monetary policy transmission mechanism. Although we formulated a model of this process (see [15]), we have rejected it for use in the context of a quarterly model since the choice of this policy instrument violates the second and third criteria listed above. Over periods as long as a quarter the target level for the excess cash ratio is clearly heavily dependent on the behaviour of intermediate target variables, i.e. variables such as interest rates that are controlled only indirectly yet are viewed as links with the level of employment and other ultimate objectives of monetary policy. Since the third criterion of statistical exogeneity cannot be satisfied even by intermediate target variables and since policy actions are themselves influenced by economic events, we have attempted to surmount these problems by formulating a central bank reaction function.

2 Intermediate targets and the reaction function

The main intermediate targets of monetary policy appear to be interest rates, the rate of growth of the money supply or bank assets, and the rate of growth of bank loans. The levels of

these variables deemed appropriate are determined with a view to the ultimate objectives of full employment, price stability and balance of payments considerations. Our reaction function is formulated in terms of an equation explaining the short-term interest rate (RS, equation 17.1) as a function of other intermediate targets and measures of policy objectives.

The empirical experiments using a distributed lag function of the rate of growth of bank loans as the intermediate target produced the best results. In terms of ultimate policy objectives, the rate of change of prices and variables related to the balance of payments entered significantly. The U.S. bill rate was used with different coefficients for the fixed and flexible exchange rate period. The results imply somewhat greater concern with stabilizing the exchange rate in the flexible rate period than with stabilizing foreign exchange reserves in the fixed rate period. A dummy variable was used to explain the tightening of policy that occurred in the exchange market crises of 3Q62 and of 1Q68 and 2Q68. Experiments with other variables such as reserve holdings and balance of payments deficits failed to yield satisfactory results. The percentage change in the stock of outstanding government bonds was included to represent debt management considerations. The coefficient measures the extent to which the central bank permits the interest rate to rise in response to the pressure of government borrowing.

D Determination of Bank Assets

1 Cash reserves (Equations 16.1-16.4, and equation 16.7)

The equations for cash reserves were obtained by a combination of multiple regression and a priori choice of parameters approximating institutional relationships. Equation 16.1 for statutory deposits in chartered banks (DSTATB) approximates the definition of statutory deposits, which is in terms of average Canadian dollar deposits over the preceding month. Since our variable DSTATB is defined as statutory deposits outstanding for the last month of the quarter, it should be approximately equal to a simple average of beginning- and end-of-quarter actual deposits. Fitting a least squares regression on current and lagged actual deposits yielded a nonzero constant term and slightly different weights reflecting, among other things, the fact that items in transit (float) are netted out of Canadian dollar deposits (DCDPB) although they are included in DSTATB. The significant seasonal effects reflect seasonal differences in the intra-quarter patterns of variation in deposits that lead to seasonal differences in the relationship between average deposits and beginning- and end-of-quarter values.

The equation for the average required cash reserve ratio (RBCR, equation 16.4) is based on a priori coefficients chosen to approximate the requirements under the 1954 and 1967 revisions of the Bank Act. Until June 1967 RBCR was simply equal to 8%. Thereafter, the required minimum monthly average ratio for demand

deposits was increased in steps of one-half of 1% per month to 12%, while the ratio for notice deposits was similarly decreased to 4%. In our equation the components of statutory deposits are approximated by simple averages of beginning- and end-of-quarter values, and an adjustment is made to allow for the fact that personal chequing accounts are included with personal savings deposits in DPB rather than in DDB, even though they are subject to the higher reserve ratio.

In Equation 16.2, we explain chartered bank holdings of Bank of Canada notes (ABBCN) based on a simple behavioural hypothesis. The banks are assumed to hold an inventory to meet projected demand as reflected in the public's currency holdings and seasonal variables. A negative correlation with changes in currency holdings is also included to reflect the buffer-stock role of bank inventories.

Holdings of statutory Bank of Canada notes (ABSTATN), i.e. notes that are eligible to meet statutory cash reserve requirements, are calculated with a one-month lag in the same manner as statutory deposits. This variable was thus approximated in terms of actual notes at the beginning and end of a quarter. Seasonal variables were included to allow for the distortion of the end-of-quarter values caused by the strong seasonal pattern in note holdings.

Given excess cash reserves at the end of a quarter, which are taken as exogenous, chartered bank deposits at the Bank of Canada (ABBCD) are then determined in the identity (equation 16.7) relating total statutory cash to required and excess components.

2 Bank loans (Equations 16.5, 16.6)

The equations for personal loans (ABLP) and business and other general loans (ABLB) are formulated as reduced-form equations derived from supply and demand functions. Demand is represented by current-dollar cash requirement variables defined as consumer expenditure on durables in the case of personal loans, and business investment less cash flow in the case of business loans. Supply is assumed to be a function of a credit availability measure (defined as (RABEL-RABELD)/RABEL) based on bank liquidity. We define RABEL as the ratio of chartered bank earning liquid assets, less required secondary reserves, to total assets. RABELD is obtained by fitting a Lagrangian polynomial through the troughs in the RABEL series that occurred at January 1957, September 1959, August 1962, and December 1969. This trend line is used to allow for the fact that the minimum value of RABEL reached during these four periods of monetary tightness has declined from 20.1% in 1957 to 12.6% in 1969. Because in each case the trough in RABEL has been followed by a sharp levelling off in loan growth, the variable is used in a nonlinear form.

The best results for the liquid asset ratio variable were obtained by using a discrete lag of one quarter for personal loans and a constrained five-quarter polynomial lag for business loans.

3 Response of the banking system to monetary policy

The model outlined above implies the following role for the banking system in transmitting changes in monetary policy. (See flow chart in section A above.) Suppose the central bank raises its interest rate target in response to a change in internal or external economic conditions. This will require a contraction of the banking system achieved by a reduction in the reserve base, the magnitude of the fall in deposits being determined by the elasticity of the demand for deposits with respect to the interest rate. The fall in deposits will be matched on the asset side initially by declines in reserves and earning liquid assets. Consequently the reduction in the earning liquid asset ratio will dampen the rate of growth of bank loans, the magnitude of this effect being larger the closer is the initial liquidity ratio to the threshold value represented by RABELD. The lower liquidity ratio, as well as the higher interest rate, will then have a contractionary effect on aggregate demand.

An alternative view of the model is provided by considering the behaviour of the banking system under a constant interest rate target. In this circumstance the level of total deposits will be determined by demand since any increase in deposits will have to be supported by increases in the reserve base at the beginning of the next averaging period so as to maintain the interest rate target. In particular the supply of deposits will be adjusted to any changes in demand related to fluctuations in income. However, to the extent that an increase in income is generated by increased expenditure on durables and therefore

leads to increased demand for bank loans, two dampening factors come into play. First, the liquidity ratio will decline leading to a tightening of credit availability. Second, inclusion of the rate of growth of loans in the reaction function implies that the central bank will resist the loan growth by raising its interest rate target.

E The Structure of Interest Rates

1. The term structure (Equations 17.2-17.4)

The equations for intermediate and long-term interest rates are based on the Modigliani-Sutch [45] version of the expectations theory, which postulates that yield differentials between short-term bonds and those of other maturity classes depend on expectations regarding future levels of interest rates. Expectations are represented by distributed lag functions of past values of the short rate with weights that are estimated subject to polynomial constraints. Regression experiments suggested a lag of twenty quarters, and peaked lag distributions were obtained indicating a strong extrapolative component in the expectations process.

Additional variables were included in the regressions to reflect factors other than past experience that might influence expectations. First, the spread between U.S. and Canadian short rates was entered to allow for the fact that a large spread is likely to generate expectations of changes in the Canadian rate

given the close relationship between the two capital markets. Second, the spread between the long and short rate in the United States is included as a measure of expected future movements in U.S. rates. Third, the expected rate of increase of the price level is used to reflect the interconnection between expected rates of inflation and expected future nominal interest rates.

Relative supply variables were also tested, but the only evidence that they have any effect was the marginally significant coefficient obtained in the RL equation.

2 Rates of interest on deposits (Equations 17.5-17.7)

Equations are included in RDX2 for those rates of interest on deposits that are particularly sensitive to other market rates of interest. The rate on chartered bank nonpersonal term and notice deposits (RNPT) is determined by the short-term interest rate (RS) with different coefficients for two subperiods in the sample. Prior to 1962 the chartered banks followed a policy of tying the term deposit rate to the treasury bill rate (which is not used in RDX2), whereas more recently the term deposit rate has been set to reflect a broader range of competitive factors in the money market.

The rate of interest on foreign currency swapped deposits (RSWP) is tied to the covered Euro-dollar rate, and the yield on trust and loan company term deposits (RTTL) is a distributed lag function of the short-term interest rate. Rates of interest on chartered bank personal savings deposits (RPD), and trust and

loan company savings deposits (RSTL) are treated as exogenous to RDX2 at present.

F The Market Value of Real Capital and the Supply Price of Capital

1 Estimation of a time series for the market value of real capital

A time series for the market value of domestic business fixed capital assets and inventories was obtained by applying to the aggregate book value of these assets a valuation ratio obtained from balance sheet and stock market data for the seventy-six largest nonfinancial corporations whose shares have been traded on Canadian stock exchanges continuously since 1955. An estimate of aggregate book value was obtained by accumulating business investment expenditure at historic cost and deducting depreciation at the declining-balance rates specified for tax purposes (5% per annum for structures and 20% per annum for machinery and equipment).

The market value of the capital assets of the firms in our sample was estimated by assuming that the market values of financial assets and liabilities are equal to the book values. Thus, given the market value of the firms' equity, the market value of capital assets can be calculated as follows:

Market value of capital assets = Market value of equity
  - Net financial assets at book value

An aggregate valuation ratio was then obtained by dividing the total market value of capital assets of firms in the sample by the total book value. The market value of the capital stock for all firms (VKB) was estimated by applying this ratio to the aggregate book value.

This time series for the market value of the domestic capital stock was used, in the manner discussed below, to derive the supply price of capital. The series was also used as a component of private sector wealth (V, equation 18.4), after an adjustment was made for the portion held by non-residents using the ratios RVB12 and RVB13 discussed in section D of Chapter 10.

2 A model determining the supply price of capital

The supply price of capital, following the terminology of James Tobin [53], is the rate of return required to induce investors to hold the existing stock of real capital in their portfolios. In view of certain recent developments in monetary theory, which suggest that the supply price of capital is a key link between the financial sector and expenditure decisions, we have attempted to approximate this variable empirically in RDX2. To distinguish the theoretical concept from our empirical approximation, we have adopted the convention of referring to the former as r and the latter as RHO. Given r and the expected future earnings stream x(t), the market value of real capital, v, is simply the present discounted value given by:

$$v = \int_0^{\infty} e^{-rt} x(t)dt$$

If the earnings stream is assumed to grow at a constant rate, g, beginning at an initial level, x, this integral reduces to:

$$v = x/(r-g) \qquad (1)$$

The rate of growth, g, is assumed to be equal to the expected rate of change of the price level as represented by a distributed lag function of past four-quarter rates of change of the Consumer Price Index (PCPI) and an error term:

$$g = JW\,[J4P(PCPI)] + u \qquad (2)$$

It should be noted that the expected rate of growth of earnings refers solely to earnings expected to accrue to holders of the existing stock and excludes earnings generated by future additions to the capital stock financed by new saving. Therefore, we assume that the expected rate of growth of earnings depends on past rates of change in the price level but not on changes in real output or profits. Inflation-induced capital gains will be the only source of earnings growth if productivity gains induce proportional increases in the real wage rate. This behaviour is in fact consistent with our main business wage determination equation, which yields an equilibrium elasticity of the real wage with respect to the labour efficiency variable (ELEFF) close to unity.

The determination of r through the portfolio preferences of investors is represented by a reduced-form equation derived from the supply and demand for real capital. The demand is assumed to depend on r and the long-term Government of Canada bond rate (RL). The differential between these rates of return is made a function of relative supply as measured by the ratio of the earnings stream from real capital, rv, to interest paid on government debt, h, and an error term, w. Thus, we have:

$$RL - r = a + b(rv/h) + w \tag{3}$$

Using (1) to eliminate r from (3), we obtain:

$$RL - x/v = g + a + b(x + gv)/h + w \tag{4}$$

Substituting for g using (2) yields:

$$\begin{aligned} RL - x/v = {} & JW\,[J4P\ (PCPI)] + a \\ & + b\,[x + JW\,[J4P\ (PCPI)]v]/h \\ & + u + w + b(v/h)u \end{aligned} \tag{5}$$

3 Empirical estimation of the supply price of capital and the expected rate of inflation

Estimates of the parameters were obtained from a regression, based on (5), of RL-x/v on past rates of change of prices and the relative supply variable (equation 18.1). The current level of earnings, x, from the stock of real capital is taken to be the

sum of corporate profits net of tax accruals, corporate interest paid, net income of nonfarm unincorporated business less imputed labour income, and the profits of government business enterprises. A four-quarter moving sum of earnings is used, and v is the average of the beginning- and end-of-quarter values of VKB.

Since the weights in the expected rate of inflation variable enter nonlinearly in (5), the estimation was carried out using an iterative procedure. Almon polynomial constraints were employed to estimate the distributed lag weights on past changes in prices. The distributed lag weights obtained from this regression were used to generate a time series for the expected rate of change of prices (PCPICE, equation 18.2). Because error terms are included in equations (2) and (3), two different estimates of r can be obtained. From the definitional equation (1) r can be estimated as x/v+PCPICE and from the reduced-form portfolio equation (3) we have r=RL-a-b(x+PCPICE*v)/h. In the absence of any information concerning the relative size of the errors, we simply took an average of these two expressions to obtain a time series for RHO. The corresponding real rate of return, RHOR, is then obtained by subtracting PCPICE.

G The Mortgage Market

Our model of the mortgage market consists of equations for the rate of interest on conventional mortgages (RMC, equation 17.8) and for the supply of mortgage funds by non-bank financial

institutions (equations 17.9 and 17.10). Supply functions for trust and loan companies and life insurance companies are specified in the form of lagged adjustment models explaining the flow of mortgage approvals. Direct lending by CMHC and chartered bank approvals are treated exogenously. We have not attempted to include an equation for banks because they were not active in the market for a major part of our sample period (1960-1966). During this period mortgage rates rose above the 6% ceiling then in effect on bank loan rates.

1 Mortgage approvals

The mortgage approval equations are based on a stock-adjustment model modified to allow for the forward commitment procedure whereby institutional lenders agree to advance mortgage funds considerably before their actual disbursement. In view of this lag between approvals and disbursements, the usual stock-adjustment model is clearly inadequate. Our modified model can be derived as follows. For any time period we can write:

$$a = c - J1L(c) + d$$

where a is approvals, c is outstanding commitments at the end of the period and d is disbursements. The latter two variables can be approximated as distributed lag functions of current and past approvals:

$$c = JW(a)$$

$$d = JW(a)$$

In a full steady-state equilibrium when the stock of mortgages is constant at the desired level, the stock of outstandings will be equal to some multiple, k, of the stock of mortgages, where k depends on the weights in the distributed lag function relating c to a. We thus postulate that approvals are related to the desired stock of mortgages, m*, in the following way:

$$a = \gamma[km^* - J1L(c)] + d$$

In equilibrium, we will then have approvals equal to disbursements and a constant stock of mortgages and outstanding commitments. Approvals will exceed disbursements if the outstanding stock of commitments is below the equilibrium level.

Substituting for c and d we obtain a relationship of the form:

$$a = \gamma km^* + JW(a)$$

The desired stock of mortgages is assumed to be proportional to assets with the factor of proportionality dependent on interest rates in the form of the differential between a simple average of the NHA mortgage rate (RNHA) and the conventional mortgage rate (RMC), and the yield on long-term Government of Canada bonds (RL).

An additional interest rate variable was constructed to allow for the effect of the ceiling rate on NHA mortgages. This

ceiling rate was an effective constraint until the end of 3Q67. In 4Q67 the ceiling rate was set at 2.25% above the long-term Government of Canada bond yield. Subsequently the ceiling was removed altogether. Assuming that this 2.25% spread approximated the threshold beyond which the ceiling was no longer an effective constraint, we represent the effect of the ceiling by the differential between the bond rate plus 2.25% and the NHA rate. This additional interest rate variable was then multiplied by a dummy (QNHA), which takes on a zero value after 3Q67.

Since approvals may be made on the basis of expected future inflows of funds, we also included the four-quarter rate of change of assets in the case of trust and loan companies and of policy loans in the case of life insurance companies.

2 The conventional mortgage rate

The equation for the conventional mortgage rate is based on a market adjustment equation in which the change in the rate is assumed to be a function of excess demand. Disequilibrium is assumed to involve some form of non-interest rate rationing that generates observations on the supply curve but not necessarily on the demand curve. Thus, the actual supply in the form of the flow of approvals is included along with variables assumed to determine demand. These demand variables include income, number of households, prices, the existing stock of houses, and QNHA, the dummy variable described above.

CHAPTER 10

THE LONG-TERM CAPITAL ACCOUNT

SECTORS 19-20

A Introduction

Sector 19 of RDX2 contains a set of equations explaining quarterly long-term capital movements between Canada and the United States, and between Canada and other countries. Sector 20 is composed of equations determining international indebtedness accounts that, in conjunction with the relevant rates of return, are used elsewhere in the model to explain the international flows of interest and dividends required to service international investments and changes in retained earnings. Sectors 19 and 20 refer only to the long-term capital account. Equations for the short-term capital account and the foreign exchange market are contained in Sector 21 and explained in Chapter 11; the interest and dividend equations are among the foreign trade relationships of Sector 4.

The equations for the capital account and the related current account items of the balance of payments can be used within RDX2 to indicate the balance of payments consequences of alternative domestic and foreign policies. The separate explanation of current and long-term capital account flows between Canada and the United States, and between Canada and other countries allows us to disaggregate the U.S. flows to a

greater extent in order to make use of the U.S. variables explained within the MPS model.

This chapter is divided into four further sections. In section B there is a brief outline of the theoretical framework employed. Section C contains explanations of the equations explaining long-term capital movements, section D is devoted to the asset and liability accounts, and section E contains our summary comment. Within section C, we discuss the equations in approximately the order in which they appear in the structure of RDX2.

B Alternative Theoretical Approaches

1 Debtor models vs creditor models

"Neither a borrower nor a lender be..." - life is more fun as a quasi-reduced form. In the case of most purchases of one country's securities or real assets by residents of another country, the available equations and data are based on the assumption that foreign holders of securities receive the same return as domestic holders of similar securities. There is one class of securities that may merit special attention - domestic bonds or shares having their capital value and/or interest or dividend payments set in terms of a foreign currency. U.S.-pay bonds and shares issued by Canadian borrowers, particularly bonds, are important examples. It would be possible, on the basis of some (fairly unrealistic) assumptions, to treat

separately the markets for Canadian-pay Canadian securities and for U.S.-pay Canadian securities, and to determine separate interest rates for each kind of security. There could be separate supply and demand equations for U.S.-pay Canadian securities, and the resulting quantity traded could be interpreted (if Canadians were assumed not to hold such securities as assets) as one component of the capital flow between Canada and the United States. In this case (examined in some detail by Freedman [20]) it is not necessary to combine borrower and lender behaviour into a single quasi-reduced form equation.

Except for the class of securities noted above, foreign-held Canadian securities do not represent a distinct commodity for which there can be independent supply and demand equations. The change in the quantity of Canadian securities held by foreigners therefore cannot be interpreted simply as the securities-demand equation of foreign lenders or the securities-supply equation of domestic borrowers, but must contain both supply and demand elements. We therefore refer to our capital flow equations as quasi-reduced form equations to emphasize that they must contain the relevant supply and demand variables.

When international portfolio behaviour is being modelled, any ambiguity about the nationality of the decision-maker raises statistical problems. In which country's currency should the flow be normalized in order to avoid heteroscedastic errors? If the flow is to be normalized by a portfolio growth variable, should the scaling variable represent the growth in the borrower's liabilities or in the lender's assets? Our split

between new issues and trade in outstanding securities helps to deal with these questions, but in some cases the questions remain unanswered. However, by distinguishing between new issues and trade in outstanding securities, at least in the equation for Canadian bonds held by U.S. residents, we were able to treat some flows as primarily borrower-determined and others as primarily lender-determined. Although these considerations influenced our choice of an estimating form for the equations, we have in all cases tried to include demand influences in the supplier-oriented equations, and vice versa.

2 Pure flow models vs pure stock models

Many of the earlier empirical studies of Canadian international capital flows are of the so-called pure flow variety. The dependent variable is a capital flow and the independent variables include a rate-of-return differential and perhaps other variables reflecting exchange rate expectations, risk, and requirements for funds. This formulation has been subjected to theoretical criticism because: (a) it ignores realignment of existing portfolios in response to a change in the international rate-of-return differential, and (b) in its usual form it implies a continuing capital flow in response to a given and unchanging rate-of-return differential even if lenders' and borrowers' portfolios remain unchanged in size. The theoretical defences of the pure flow model must rest, in the first case, on the existence of relatively high decision-making and portfolio-switching costs. In the second case the model can only be

defended as a linear approximation that is reasonably correct if the flow of new investible funds is relatively constant. These defences are not really adequate, because, even if all portfolio adjustment has to take place via portfolio increments, the existing size and structure of the portfolio ought to influence the allocation of portfolio increments in response to given rates of return. As for the second defence, there is really no need to treat a multiplicative relationship as though it were additive.

The pure stock theory, by contrast, makes the stock of an asset a function of a rate-of-return differential, and sometimes of the total wealth of the assumed investor. If this model is fitted in first-difference form, then the capital flow is the dependent variable with the independent variables being the change in the rate-of-return differential and the change in portfolio size. Depending on the functional form used for estimation, this model, like the pure flow model, can have unrealistic equilibrium properties. For example, if the equation were fitted in linear form with the stock of the asset held by foreigners as the dependent variable and with the rate of return and the size of the foreign portfolio as independent variables, then the equation would imply that the rate-of-return effect was independent of portfolio size. If no allowance is made for lags in the adjustment process, the pure stock model implies rates of capital flow that become infinitely large as the length of the observation period approaches zero.

If portfolio size variables are omitted, then neither the pure stock nor the pure flow model is theoretically appropriate. If the pure stock model is estimated with the stock taken as a

fraction of the relevant portfolio size variable, then the pure stock model can be appropriate with or without portfolio growth, but only if the portfolio adjustment is costless and immediate.

If lags occur in the portfolio adjustment process, then a theoretically appropriate model must contain some elements of both the pure stock model and the pure flow model. Increments to portfolios may well be allocated according to the pure flow model based on one sort of lag process, although realignment of existing portfolios may be better described by a pure stock model based on some other lagged adjustment process.

Neither the pure stock nor the pure flow model takes account of the difficulty, mentioned in the previous section, that at least two portfolio magnitudes are relevant to the capital flow - the borrower's debts and the lender's assets.

3 Stock-adjustment models with lagged responses

The discussion above suggests that total capital movements may depend on two lag processes operating in response to portfolio growth and to rate-of-return differentials. One advantage of the split between new issues (treated primarily as a borrower decision) and trade in outstanding securities (treated as lender behaviour) is that it may help to unscramble these two lag processes. Borrower equations can show how new issues are allocated to various lending countries in the light of current or slightly lagged rates of return on new issues. On the other hand, lender equations may show a much longer distributed lag process of adjustment (because of decision-making and transaction

costs) to the proportions desired in the light of rates of return and risk considerations. Retirements of securities and the flow of new issues determined by the borrower equations will directly influence the lagged stock of securities, which is an important variable in the lender equations.

Most of the lender equations reported in this chapter are based on the assumption that portfolios are adjusted according to a pattern of geometrically decaying distributed lag weights. This assumption gives rise to the familiar stock-adjustment model as the preferred estimation form.

4 Transactions costs, exchange rate expectations, and risk considerations

Transactions costs may introduce substantial nonlinearity into the effect of rate-of-return differentials on the international distribution of new issues and on the realignment of existing portfolios. The existence of such costs could lead, under appropriate assumptions, to smaller equilibrium portfolio proportions invested in assets with higher transaction costs and to different speeds of portfolio adjustment in response to rate-of-return differentials of different sizes. A threshold model might be used appropriately to describe the responses of an individual asset-holder to changes in rates of return. A model for the investment of portfolio increments might well be different than one for reallocation of existing portfolios, since the former involves only the costs of search and purchase whereas the latter involves the costs of sales transactions as well.

Even if a pure threshold model were applicable for an individual portfolio owner, its edges become blurred when aggregate portfolio responses are being estimated. The situation gets even more complicated if the range of substitute securities changes over time, or if changes occur in transactions costs or in the risk characteristics of the available securities. When attempting to construct a manageable and empirically testable model, one must make some simplifying assumptions to reduce the extent to which these complications influence the structure of the equations. In our experiments with various nonlinear rate-of-return variables designed to capture the influence of transactions costs, we implicitly assumed that representative national rates of return were the only variables interacting with transactions costs. Thus we could represent the effects of transactions costs by inelastic portions of the partial relationship between target portfolio proportions and international interest rate differentials, or supply price of capital differentials. The functional form we used was the same as that employed to represent the 'rules of the pegged exchange rate game' in our equation 21.1 for the official demand for foreign exchange. If R1 is the domestic interest rate, and R2 the foreign rate, the variable takes the form:

$$[R1-R2]/[C-(R1-R2)(R1-R2)]$$

The constant C is the square of the limit to the difference between R1 and R2, the point at which supply or demand becomes perfectly elastic. The values of C tested all had square roots

greater than the historical maximum for R1-R2. Although we tried a number of different values for the permissible range of the interest rate differential, these nonlinear formulations generally fitted less closely than the usual linear model that ignores transactions costs.

Exchange rate expectations, one may safely assume, are formed differently under pegged and floating exchange rates. Under a floating exchange rate system, each participant may have his own idea of a normal exchange rate based either on some autoregressive process or on forecasts of the presumed market forces. Under a pegged exchange rate system, a similar process may apply during 'normal' conditions, with an entirely different process coming into play when the exchange rate hits a support point and forces heavy official buying or selling of reserves. Furthermore, the kind of expectations process that is relevant depends on the nature of the capital flow. The issuer of bonds in a foreign currency is concerned about the likely change in the exchange rate between the date of issue and the date of retirement. The portfolio purchaser of securities, on the other hand, may be guessing about exchange rate changes within his planned holding period, which may be only a few days or a few months. In our equations we tried various ways of modelling exchange rate expectations, including building them into rate-of-return differentials. Only two of these ways were successful in confrontation with the data. We used special variables to represent particular times of doubt during the fixed exchange rate period, using the same formulation that plays such an important role in our model of the foreign exchange market.

During the flexible rate period, we obtained some slight help from the linear difference between the actual exchange rate and an assumed value of $1 Canadian = $1 U.S.

Subjective risk variables, which provide a theoretical rationale for two-way capital flows, do not appear in our models of capital movements except in the form of variables reflecting expectations about the likelihood of particular events. There are two reasons for this situation. On the one hand, a critical survey of the variables that have been suggested as 'risk proxies' usually shows these variables to be open to diverse interpretations and likely to represent a jumble of other factors. On the other hand, in the process of simplifying theory to the point where it can be tested with small data samples, researchers who have had to suppress third country rates of return and other important influences can fairly easily persuade themselves that the dispersion characteristics of subjective probability distributions of rates of return (and the relevant covariances) are either stable over time or so unstable that suitable proxy variables cannot be found.

C Equations for Long-Term Capital Movements

In several cases, particularly in dealing with capital flows between Canada and other foreign countries (i.e. excluding the United States), the available rate-of-return and portfolio size data did not permit us to disaggregate capital flows as much as might be theoretically desirable. In other cases aggregation was natural because the disaggregated flows are small. Where

disaggregation was undertaken, as in the case of Canadian government and corporation bonds sold to U.S. residents, we treat retirements of foreign-held domestic bonds as exogenous variables, since they are not generally responsive to current conditions and are fairly easily forecast from independent information. Aside from retirements and some official new issues, the exogenous categories of long-term capital flows are Columbia River Treaty payments, government loans and advances, export credits, and miscellaneous long-term items not included elsewhere. These latter items are combined as FIL012 and FIL013 in the balance of payments identities.

In this section we present first the equations for direct investment flows from the United States to Canada, from other countries to Canada, and from Canada to the United States. Direct investment by Canada in countries other than the United States is treated as part of an aggregate long-term capital flow to those countries. We then discuss portfolio capital flows from the United States to Canada. In the third part of the section we consider portfolio capital inflows from other countries to Canada. Finally, we deal with portfolio capital flows from Canada to the United States, and total direct and portfolio long-term capital movements from Canada to countries other than the United States.

1 Direct investment

The theory underlying the direct investment equations is that flows, e.g. from the United States to Canada, ought to

depend positively on the marginal efficiency of capital in Canada and the supply price of capital in Canada. The former influence is self-explanatory. The latter influence arises because funds from a U.S. parent company, or from U.S. financial markets, and funds raised in Canada represent alternative sources of funds for Canadian firms either controlled in the United States or ripe for takeover by a U.S. firm. Correspondingly, the direct investment inflow from the United States to Canada ought to depend negatively on the marginal efficiency of capital in the United States and the supply price of capital in the United States. Since the aggregate level of investment expenditure is explained elsewhere in the RDX2 and MPS models, taking appropriate account of the factors determining the marginal efficiency of investment, we can use the level of investment expenditure as a predetermined variable in the direct investment equations. Only in the case of direct investment flows from the United States to Canada were we able to capture the separate influences of the attractiveness of investment opportunities in the two countries and of the difference between the supply prices of capital in the two countries. Even in this equation, as in any bilateral capital flow equation, we ought to have been able to capture also the effects of changes in investment opportunities or the supply price of capital in third countries. This would be too much to expect, given the indivisibilities and special factors involved in direct investment decisions.

FIDI12 Direct investment in Canada from the United States (Equation 19.1)

Although we made in the previous section what we thought was a fairly clear distinction between borrower and lender behaviour, we are presented in our very first equation with an apparently special case. Direct investment decisions are lender decisions all right, but the model is set up with direct investment estimated as a ratio to the product of a four-quarter moving average of Canadian corporate requirements for funds weighted by the share of business assets financed by direct investment from the United States. The total requirement for funds is defined as business fixed investment expenditure minus the sum of corporate retained earnings and book depreciation allowances. Requirements for funds are defined net of internally generated funds to match the balance of payments definition of direct investment inflows, which are measured net of any funds provided by retained earnings.

The reason for this apparent jumble of lender and borrower behaviour is that the corporate requirements for external funds are the result of decisions made by all Canadian firms, including those controlled in the United States. Ideally, we should like to be able to treat the take-over portion of direct investment separately and to estimate the non-take-over segment as a ratio to the external funds requirements of only those Canadian firms directly controlled in the United States. Although the available data are not good enough to permit separate treatment of the take-over portion of direct investment, we attempted to relate the cash requirements variable to the proportion of business

financing normally provided by U.S. parent companies. This is done, as mentioned above, by multiplying the aggregate cash requirement by the ratio of the stock of U.S. direct investment (LDIRV12, measured at replacement value) to total Canadian business fixed assets and inventories (KB$, also measured at replacement value). If anything happens to influence the current share of investment financed by FIDI12, this will alter the ratio LDIRV12/KB$ and thus alter the share of new financing thereafter 'normally' provided by U.S. direct investment.

The main causal variables in the equation, in addition to corporate cash requirements, are a nine-quarter distributed lag on the difference between the nominal supply price of capital (RHO) and the corresponding U.S. variable (RHO2), and a U.S. requirement-for-funds variable. The U.S. cash requirements variable is the U.S. equivalent to the Canadian corporate cash requirements variable, divided by total personal savings. It might be argued that we ought to use the differences between the real supply prices of capital, RHOR and RHOR2, rather than the nominal figures. If RHO-RHO2 differs from RHOR-RHOR2, then expected price changes are different in the two countries. If exchange rates are pegged, or if there are other factors restricting expected movements towards purchasing power parity, then the RHO differential may be more appropriate than the RHOR differential.

The two remaining variables are EGUIDE covering the period of application of the U.S. balance of payments guidelines, and ZDEPREC covering the period of adjustment to accelerated depreciation allowances made available in mid-1963 to firms with

25% Canadian ownership or with shares listed on a Canadian stock exchange. In both cases the apparent response of direct investment may have been as much a preemptive response to expected future measures as a direct response to the actual measures. This is particularly likely to be so in the case of the U.S. guidelines, which did not explicitly apply to direct investment in Canada (except in 1Q68) unless it was being used as a means of passing funds through Canada for portfolio investment abroad.

FIDI13 Direct investment in Canada from other countries (Equation 19.2)

Since there are so many 'other countries', it is not possible to obtain an equation taking adequate account of competing uses for funds. As with direct investment from the United States, the direct investment inflow from other countries is estimated as a fraction of Canadian corporate cash requirements. There are two differences to note in the definition of cash requirements. A four-quarter moving average is used for FIDI12, this being the shortest lag that eliminates the purely seasonal variation in cash requirements. By contrast, a twelve-quarter moving average provides much better results for FIDI13, suggesting less immediate links between expenditures and direct investment inflows from parent companies in countries other than the United States. The second difference is that the liability accounting for other countries is less detailed than that used for debts to the United States, so we use a variable (LDIPRV13/KB$) involving both direct and portfolio investment to

represent the share of new financing 'normally' provided from foreign countries other than the United States.

Since we were unable to develop an 'other countries' equivalent to RHO or RHOR, we took the U.K. long-term bond rate (RLUK) to represent the alternative supply price of capital, and used a distributed lag on the differential between RHO and RLUK spread over fourteen quarters. This distribution seems long, but it is empirically stronger than any of the shorter distributions fitted. The other variable in the equation is QOIL, accounting for the identified foreign financing (in 4Q62) of the takeover of a large Canadian oil company.

FODI12 Direct investment from Canada in the United States (Equation 19.3)

This flow is estimated as a proportion of the Canadian dollar equivalent of U.S. corporate cash requirements, which turns out to be the only determinant that is both theoretically and empirically important. QSALE is empirically important, but of little theoretical interest because it has only one positive observation, in 3Q66, to account for an identified sale of a large U.S. subsidiary by a Canadian corporation.

2 U.S. portfolio investment in Canadian securities

Dealing with portfolio investment from the United States, our first decision was to declare retirements of all foreign-held Canadian bonds and new issues of Government of Canada direct and guaranteed bonds sold to foreigners to be exogenous variables. Since most bonds are retired only when they are due, it is natural to treat retirements of bonds as predetermined, and to forecast them by means of specific information about maturity dates of large issues held by foreigners. New Government of Canada issues of bonds to foreigners, especially foreign-pay bonds, are properly regarded as policy variables, except to the very minor extent that foreigners purchase new government issues in the Canadian bond market. Indeed, the only Government of Canada foreign-pay issues of major size in recent years were occasioned by the 1962 and 1968 exchange crises.

Still to be considered are new issues of corporate bonds, new issues of provincial and municipal (P&M) bonds, trade in outstanding bonds of corporations, trade in outstanding bonds issued by each of the three levels of government, and portfolio transactions in shares of Canadian corporations. We separate new corporate and P&M issues because they depend on different factors. There are two reasons for separating trade in outstanding government and corporate bonds. First, the new issue equation for each sort of bond depends more on the stock of that category of bond in the hands of U.S. holders than on the stock of both sorts combined. Second, we need to keep government and corporate bonds separate to help define our series (RVB12) for

the percentage of Canadian business fixed assets and inventories owned by U.S. residents.

We turn now to a discussion of the individual equations.

FINIPM12 Sales of gross new issues of provincial and municipal direct and guaranteed bonds in the United States (Equation 19.5)

This flow is presumed to depend primarily on decisions of borrowers and is estimated as a proportion of total gross new issues of P&M bonds (GBRPM), a series explained elsewhere in the model. (See equation 14.11.) Some reasonable equilibrium properties are guaranteed in equation 19.5, since a zero value for the flow will be predicted when provinces and municipalities are not issuing any new debt.

Although we experimented with interest differentials as well as liquidity measures, we found that the U.S. borrowing ratio was more closely related to Canadian bank liquidity than to the interest differential. One reason for the insignificance of the interest rate series is that the two rates we employ are those on outstanding Government of Canada bonds (RL) and U.S. corporate bonds (RCB2), while in times of bond market tightness a large new issue might well have to bear a significantly higher interest rate than that obtaining on outstanding issues.

Our measure of the tightness of the domestic bond market is the indicator of credit availability explained in section D of Chapter 9. The variable is based on the difference between the earning liquid asset ratio of the chartered banks (RABEL) and its target value. The target value, RABELD, declines through time.

The U.S. borrowing proportion, which averaged about 22% between 1956 and 1968, was also apparently affected by the exchange rate uncertainty, or by the policy announcements of the federal government discouraging foreign borrowing, or both, at the end of the flexible exchange rate period. We have defined the relevant period (following Freedman [20] p.119) to be 3Q60 to 3Q62 inclusive. The coefficient on QLOBO indicates a substantial reduction in the borrowing ratio during this period.

The final variable used in both new issue equations is related to the U.S. Interest Equalization Tax. EIETB takes the values -.2 from 3Q63 to 3Q64 inclusive, followed by 1 in 4Q64. The negative values represent postponements of new issues during the period when it was not certain that Canadian issues would be exempt. The passage of the law and the granting of the exemption were followed by a spate of deliveries of new issues in 4Q64.

FINIB12 Sales of gross new issues of Canadian corporate bonds in the United States (Equation 19.6)

This equation is very similar in structure to that for provincial and municipal bonds. The borrowing requirements variable is more roughly defined, being a twelve-quarter moving average of gross business fixed investment expenditure minus funds generated internally by corporations. The use of shorter averages of cash requirements gave rise to less accurate explanations of the flow FINIB12. The main difference between this equation and equation 19.5 for new P&M issues is that in the equation for corporate bonds the borrowing ratio is lower for the entire flexible exchange rate period, but not especially so

during the time when provinces and municipalities were being discouraged from foreign borrowing.

In addition, the FINIB12 equation shows some lender response, because the stock of Canadian corporate bonds held at the end of the previous quarter by U.S. residents, measured as a proportion of U.S. household wealth, enters with a negative sign. The stock of debt is measured in millions of Canadian dollars and U.S. household wealth in trillions of U.S. dollars. This is the correct way of specifying the variable only to the extent that the debt is denominated in U.S. dollars. Otherwise, the U.S. equivalent of the stock of debt will change when the exchange rate changes. In equation 19.5 a corresponding variable was used but it had an insignificant coefficient with the reverse sign. This may indicate that the desired proportion of P&M bonds in U.S. portfolios has grown over time to a greater extent than that of corporate bonds. Conversely, it is possible that the Canadian market has become more inhospitable for P&M bonds than for corporate bonds. In case this were so, possibly because of the large amount of P&M borrowing, we experimented to see whether the proportion of P&M bonds or corporate bonds in domestic portfolios had an impact on U.S. borrowing ratios. We could detect no such influence.

FITOGB12 Trade in outstanding Government of Canada, provincial and municipal bonds between Canada and the United States (net sales to the United States) (Equation 19.7)

This equation is simple and quite satisfactory. It is presumed to reflect lender behaviour, whether in response to new issues by Canadian borrowers or to changes in interest rates. The U.S. portfolio share devoted to Canadian bonds is assumed to depend only on the difference between Canadian and U.S. long-term interest rates. More precisely, the extent to which portfolio realignments take place through trade in outstanding bonds depends only on rates of return. An increase of 1 percentage point in the Canadian interest rate would lead, according to the equation, to a $57 million inflow of funds to Canada during the current quarter through trade in outstanding government bonds. The flows in succeeding quarters would become successively smaller as the proportion of U.S. portfolios devoted to securities issued by governments in Canada rose to its new equilibrium level.

Since this equation, like the other equations for capital flows from the United States, contains the lagged stock measured as a proportion of U.S. wealth, the implication is that an increase of U.S. wealth would lead to net purchases of outstanding Canadian government bonds even if interest rates remain constant. But if new P&M issues in the United States were so large as to make the stock of Canadian government debt held in the United States rise at a faster rate than U.S. wealth, then there would be, for given interest rates, continual sales to

Canadians by U.S. residents of these outstanding government securities.

FITOBB12 Trade in outstanding Canadian corporate bonds between Canada and the United States (net sales to the United States) (Equation 19.8)

As with the trade in outstanding government bonds, this flow depends on the Canadian-U.S. long-term interest rate differential and on the lagged stock of Canadian corporate bonds divided by U.S. household wealth. In addition, the trade depends on two exchange rate expectations variables. The first, PFX-EPFXE, is equal to the exchange rate (in Canadian dollars per U.S. dollar) minus 1 until 3Q61, equal to zero during the period of exchange rate uncertainty (4Q61-3Q62), and equal to the exchange rate minus 1.081 from 4Q62 on. When the foreign exchange rate is above its supposed 'normal' value, there is an increased incentive to buy Canadian-pay securities in order to obtain capital gains when the Canadian dollar regains its 'normal' strength. The variable assumes 'par psychology' during the flexible exchange rate period and 'peg psychology' during the fixed exchange rate period. The quantitative importance of the variable is not great, leading to an initial flow response of $2 million per quarter for each cent that the exchange rate deviates from 'normal'. This may be compared with the initial interest effect of $6 million for a percentage point increase in the interest differential. The second exchange rate variable is the speculation variable, EF68E, taken from the foreign exchange model. In equation 19.8, EF68E indicates a $6 million capital

outflow in 1Q68 and a corresponding inflow in 2Q68. By contrast, its impact in the equation for the private demand for foreign exchange is almost 100 times as great.

The equation also contains a variable covering the flexible rate period, indicating slightly greater purchases of Canadian bonds at that time. This effect, which is not significant, may well be due to the exchange uncertainty of 1961-1962 followed by the U.S. Interest Equalization Tax in effect from mid-1963. Special variables for the IET were tried without success in this equation. The effect of the IET may well be to reduce the amount of gross sales and purchases of outstanding Canadian securities between Canada and the United States without altering the net flows appreciably.

FIPVB12 Purchases of Canadian corporate shares on a portfolio basis by U.S. residents. Gross new issues, less retirements, plus trade in outstanding shares (Equation 19.9)

This equation presents the classic problem of explaining large but industry-specific capital movements in the context of an aggregate model. The net flow series shows continous inflows to Canada until 1Q61 followed by almost continuous outflows until 2Q67 and then steady inflows until the end of the data period, 4Q68. If the net inflow to Canada in the late 1950s was a hangover from the Canadian resource-based boom in the mid-fifties and the outflow in the 1960s a consequence of disillusion and tax changes, what is the best way to explain these flows within the context of an aggregate model? Even with much more

disaggregation, we would no doubt find it difficult to explain the changing fashions of investor psychology by means of actual industrial achievements.

Only after adjusting the equation to account for a number of specific factors were we able to relate the flow to relative rates of return and portfolio growth. We fitted the equation as a change-in-stocks model with separate lag patterns for the change in the rate-of-return differential and the change in U.S. household wealth. In the light of the model adopted, which fits better than the stock-adjustment model using the lagged stock, the rate of return appears as a four-quarter distributed lag on first differences of RHOR-RHOR2, and a six-quarter distributed lag on changes in U.S. household wealth. In this equation, the RHOR differential fits better than the RHO differential, suggesting that portfolio purchasers may have a time horizon long enough to take account of price expectations but not long enough to envisage a re-pegging of the exchange rate as a consequence of the differing rates of inflation. The variables allowing for special factors include: QMIDEAST, which accounts for purchases of Canadian oil shares in the last half of 1967 because of the Middle East war; QUSTAX, which accounts for portfolio realignments following removal of U.S. tax provisions favouring mutual funds holding foreign equities; and QBROKE, which represents sales of Canadian shares during 1965 in reaction to the bankruptcy of Atlantic Acceptance, a major Canadian finance company.

To ensure that the equation would have reasonable stock equilibrium properties, it was estimated without a constant term.

If the equation had been allowed to have a constant term, this term would have indicated changes over time in portfolio composition even when portfolio sizes, rates of return, and all the other supposed determinants were held constant.

3 Portfolio capital inflows from other countries

We have made only a two-way split here, between government and all other Canadian securities. This split enables us to define our variable for the net wealth of residents as well as to calculate the market values of international indebtedness. Both series encompass new issues, trade in outstanding securities, and retirements.

FIGB13 Sales of Government of Canada, provincial and municipal bonds in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds (Equation 19.10)

This flow was rather small (the largest observation was an outflow of $34 million during the exchange crisis in 2Q62) and our basic interest rate and lagged stock variables do not explain a very large proportion of its variance. The interest rate differential we employ is the Canadian long-term rate (RL) minus the U.K. long-term government rate (RLUK). The initial inflow response to a 1 percentage point increase in RL is about $12 million, with an unrealistically high eventual equilibrium stock change indicated by the very small coefficient on the lagged stock of bonds held. In this equation, as in all our equations

for capital flows to and from other countries, an aggregate that excludes only the United States, we are handicapped by lack of adequate foreign rate-of-return and portfolio size variables.

The large 1968 offerings of government bonds of Canadian issue in Europe are accounted for, rather than explained, by two separate variables. The first, the policy variable ZEUROF, is the $175 million ($ Canadian equivalent) Government of Canada second-quarter borrowing in Lire and Deutsche Marks. The second variable, QEUROPM, has the value 1/3 in 2Q68 and 1 in 3Q68. QEUROPM is intended to capture the demonstration effect that these federal bond issues had on P&M borrowing in Europe between June and September. (Hence 1/3 in 2Q68 and 1 in 3Q68.) The incentive effect was offset after that time, we assume, by the tightening of the German financial markets after revaluation of the Deutsche Mark. At any rate, the borrowing did not take place in 4Q68 on anything like the same scale as in 2Q68 and 3Q68.

FIBL13 Sales of Canadian corporate bonds and shares in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds and shares (Equation 19.11)

This equation is based on the lagged stock of Canadian private securities held by residents of other countries, Canadian corporate cash requirements as defined in equation 19.6, and the nominal supply price of equity capital in Canada (RHO). We were unable to develop a satisfactory corresponding supply price of capital in the United Kingdom, so the Canadian rate appears on its own.

The initial inflow response to a 1% increase in the supply price of capital in Canada is about $19 million, with an eventual total portfolio stock adjustment of about $770 million.

4 Portfolio flows from Canada to the United States and total flows from Canada to other countries

FOPL12 Purchases of U.S. bonds and shares by Canadians. Gross new issues, less retirements, plus net trade in outstanding bonds and shares (Equation 19.12)

This equation is estimated in terms of U.S. dollars, employing a stock-adjustment formulation wherein the lagged total value of Canadian long-term claims on the United States (A12) is included as a fraction of V, the total market value of the net worth of Canadian residents. The rate-of-return differential is RHO-RHO2, and its coefficient shows a U.S. $9 million initial response for a 1 percentage point change in RHO. It is frequently argued that the large Canadian purchases of U.S. shares in the mid-1960s were due to the unavailability of Canadian shares in the electronics and other highly technological industries showing large increases in share prices during this period. Since many of these industries are defence-related, we used a fourteen-quarter distributed lag on U.S. military prime contracts for defence goods (ODG2) as a proxy for the mix of incentives causing Canadians to purchase these shares.

FOL13 Long-term direct and portfolio investment in bonds and shares in other countries from Canada (Equation 19.4)

The model employed here, as in the case of U.S. purchases of Canadian shares, is a change-in-stocks formulation. Thus the independent variables include changes in the determinants of the stock of FOL13 and the constant term is suppressed.

To capture the incentives to invest both directly and in portfolio form in OECD countries, we used the MPS model index of OECD capacity utilization (XBCF2) to reconstruct the series for OECD industrial production. We then used an eighteen-quarter distributed lag on the changes in OECD industrial production and found it to take a humped distribution with the greatest weight between two and three years back. This may be taken to represent a crude accelerator investment model for the direct investment component, which is about two-thirds of the total flow. Domestic portfolio growth is represented by the current change in V, the market value of private sector wealth. Neither the Canadian investment opportunities variable, nor the supply price of capital in Canada helped to explain the flow.

D Accumulation of Asset and Liability Accounts

The equations described in the previous section explain all the components (except some bond retirements and other miscellaneous exogenous items) of the long-term capital account of the Canadian balance of payments. These equations depend heavily on accumulated international assets and liabilities, as

do the equations in Sector 4 explaining international receipts and payments of interest and dividends. If RDX2 is to simulate the balance of payments consequences of various policies accurately, the important international asset and liability accounts must be made endogenous to the model. This we have done in Sector 20. The requirement however, raises a number of serious difficulties.

Consider first the lesser problem of accumulating series for foreign holdings of government bonds. Such series ought to be expressed in terms of market value or book value, in either case measured uniformly in terms of a single currency. Even if these data were available, it would be no easy task to calculate the supposed interest payments. Were a book value of debt used, the relevant interest rate series would be a lengthy or extensive average of interest rates on new issues, weighted by the relevant flows, taking due account of retirements. This is roughly the procedure followed in our equation 4.16 for interest payments to the United States. If the market value of debt were used, the interest payments would not be equal to the current yield times the current value of the debt, since the debt would include many bonds valued above or below redemption price, implying that some of the yield must be attributable to changes in capital value rather than interest payments. A prior problem is involved in measuring the debt in terms of a single currency. Our disaggregation is by country of residence of debtor and creditor, with no note taken of the currency in which the debt is denominated. Although one could split the new issues by currency, no corresponding split of trade in outstanding bonds or

retirements is possible, so that any vintage accounting by currency would soon go astray. In our accounting for the book value of Canadian government debt (bonds issued or guaranteed by either federal or P&M governments, LGB12, equation 20.1), we have merely accumulated the balance of payments flows. This procedure will misstate the debt owing, on retirement, for foreign-pay issues if changes occur in the exchange rate between issue and redemption.

Whatever the problems of accumulating government debt held abroad, they are dwarfed by those of handling claims on business assets. In dealing with Canadian claims on non-residents, we explain only aggregate flows, and have no appropriate scheme for valuing business assets in the debtor countries, so we accumulate balance of payments flows to determine claims on the United States (A12, equation 20.7) and other countries (A13, equation 20.8). This procedure forces us to ignore changes in market values and exchange rates subsequent to the date of investment, but because of data limitations we have scant alternative. The consequences of mismeasuring Canadian assets are not great, because the book value of Canadian international long-term assets (A12+A13) was only 18% as large in 4Q68 as the book value of Canadian liabilities. All the asset and liability accounting described above ignores short-term capital flows, since they are only available on a net basis and therefore unsuitable for addition to the gross indebtedness series.

We can accumulate Canadian business indebtedness to U.S. and to other foreign investors using more appropriate methods of valuation. In preliminary versions of RDX2, we valued

liabilities to foreigners investing in Canadian companies at either balance of payments book value or at imputed share market value. The latter valuation involved splitting the total market value of business fixed assets and inventories (VKB) into resident-owned and foreign-owned components on the basis of interest and dividends paid to domestic and foreign residents. The book value measures were unsatisfactory because they ignored changes in the value of assets after the date of original investment. Using the interest and dividend series to split market values begs the main issue, because a sensible model must contain some mechanism explaining interest and dividends paid to foreigners in terms of some underlying liability accounting. Thus we had to fall back on our unsatisfactory book value measures of liabilities in our initial explanation of interest and dividends paid to foreigners.

We have recently substantially improved the accuracy and theoretical appeal of our liability accounting by adopting the replacement value basis developed in the course of research on the Australian balance of payments [35]. There is more detail in our treatment of liabilities to the United States, so they will be explained first.

Liabilities to U.S. residents investing in Canadian business assets arise from direct investment, portfolio investment in Canadian shares, and portfolio investment in bonds issued by Canadian corporations. The liability on direct investment account (LDIRV12) is obtained by adding the direct investment inflows (FIDI12) and retained earnings on direct investment (FIYCRE12) to a stock revalued each quarter according to changes

in the replacement price of business fixed assets and inventories. This procedure, which is shown in equation 20.4, is based on the assumption that U.S. direct investors have, on average, zero net financial assets in Canada, and acquire buildings, machinery, and inventories in roughly the same proportions as do other purchasers of Canadian business assets. This assumption is not strictly correct, because the industrial mix of direct investment by foreigners is different from that for investment by resident-controlled firms. However, the assumption is sure to be more accurate than the zero revaluation assumption implied by accounting based on balance of payments book values.

The retained earnings series used in the accumulation is obtained by spreading the annual figures (recorded in the balance of indebtedness [9]) according to the quarterly variance of total corporate retained earnings. The series is determined within the model by equation 19.13 for FIYCRE12. Here the sum of that portion of dividends estimated to apply to cumulated direct investment and total retained earnings accruing to U.S. direct investors is explained by the product of total after-tax profits and the ratio of LDIRV12 to the replacement value of total business assets. The retained earnings appear only in the liability accounting of the model because the Canadian balance of payments statistics [11] do not include them as current account outflows and capital account inflows.

The liability to portfolio investors in Canadian equities (LPCV12) is treated differently from direct investment, because there is no series for retained earnings attributable to portfolio investors. Thus the periodic revaluation of the

liability must take account of the rate of retention of earnings as well as of the rate of increase in the replacement price of business assets. This is done in equation 20.3, on the assumption that U.S. portfolio investors own shares of firms with average retention rates.

Separate accounting for Canadian corporate bonds held by U.S. residents is made possible by the equations for new issues and for trade in outstanding bonds. Equation 20.2 for LCB12 uses these series, along with an exogenous series for retirements, to accumulate the liability from the balance of payments flows. The separate accounting for bonds and shares held by U.S. residents permits the estimation of separate equations for interest and for dividends as described in Chapter 4.

Liabilities to other foreign holders of Canadian business assets are accumulated at a more aggregated level using procedures that are more approximate than those referred to above. Direct investment flows (FIDI13), retained earnings of direct investment (FIYCRE13), and portfolio purchases of bonds and shares (FIBL13) are accumulated and revalued (in equation 20.5 for LDIPRV13) on the assumption that the value of the liability increases at the same rate as the replacement price of business assets. This represents too much revaluation for bonds and too little for portfolio shares; we hope that these offsetting errors are not far different in amount. The relatively small size of the components discourages us from disaggregating to allow more accurate revaluation. The aggregate liability series LDIPRV13 is used along with the corresponding series for government bonds (LGB13, equation 20.6) to explain the

combined series for interest and dividend payments (MID$13, equation 4.20).

In addition to their roles in explaining interest and dividend payments and capital flows, the various liabilities to foreigners investing in Canadian companies are used, as a ratio of the replacement value of total business fixed assets and inventories, to remove from household wealth the foreign-owned portion of the share market value of business fixed assets and inventories (VKB). These 'foreign ownership' ratios, RVB12 and RVB13, are defined in equations 20.9 and 20.10. The liability to U.S. investors includes the book value of company bonds (LCB12), the stock of portfolio equities (LPCV12) revalued for retained earnings and price level increases, and the stock of direct investment (LDIRV12) including retained earnings revalued according to increases in the price of business assets. The liability to other foreign investors is the accumulated sum of direct investment inflows, net portfolio purchases of business bonds and equities, and retained earnings on direct investment.

E Summary and Evaluation

We used different theoretical models to explain the major components of the long-term capital account of the balance of payments. In most cases the differences were dictated by the nature of the flow being explained. In all cases we insisted that the chosen equations have acceptable equilibrium properties according to the theory of allocation of growing portfolios.

Sometimes the imposition of these theoretical desiderata has a substantial cost in terms of goodness of fit. For example, when equation 19.6 for sales of gross new issues of corporate bonds in the United States is solved for the flow FINIB12, the calculated series explains only 22% of the variance of the actual flow from 1Q57-4Q68. We do better for the other major flows estimated as ratios - explaining 72% of FIDI12, 48% of FIDI13, 65% of FODI12, and 74% of FINIPM12. We hope that eventually it will be possible to build models with good fit and good theory to explain all the major capital flows. In the meantime, we are satisfied with the theory and fit of most of the equations, and prefer theory to fit for the remainder, hoping thereby to obtain reasonable simulation properties.

It is interesting to note the long adjustment lags in most of the equations for trade in securities (e.g. FITOGB12, FITOBB12, FIGB13, and FIBL13). The slowness of the implied portfolio realignment perhaps explains why pure flow models of capital movements have often dominated their alternatives in terms of goodness of fit. We have gone further than other researchers in our attempts to develop and use appropriate portfolio size and rate-of-return variables, and have still found in some cases that our stock-adjustment models produced results not very different from those of a pure flow model.

Although the results of simulations of the long-term capital account will be presented at a later date, we can present here an assessment of the explanatory power of our equations treated in groups for the period 1Q57-4Q68. Our equations for capital inflows (the FI equations), along with the exogenous retirements

series, explain 72% of the variance of the flows between Canada and the United States and 77% of that between Canada and all countries. The equations for capital outflows (the FO equations) explain 68% of the flows between Canada and the United States and 69% of the flows between Canada and all countries. If net long-term capital flow series are constructed from the calculated values for all the FI and FO components, they explain 57% of the variance of the net flow between Canada and the United States, 84% of that between Canada and other foreign countries, and 68% of that between Canada and all countries. Even if these net series were less close-fitting than alternative equations for the net flows, we should still prefer our sets of disaggregated equations because we can accumulate assets and liabilities separately, and split them between the United States and other countries to facilitate our policy simulations and our bilateral linkage of RDX2 with the MPS model of the United States.

CHAPTER 11

FOREIGN EXCHANGE RATES, OFFICIAL RESERVES, AND SHORT-TERM CAPITAL FLOWS

SECTOR 21

A Introduction

The growing literature on international short-term capital movements generally considers the dealings of private traders, speculators, and arbitrageurs, separately or together, but ignores governmental activities. It is usually assumed that the policy authorities determine either a fixed rate of exchange or a change in the level of foreign exchange reserves, with the value of the other factor left to be determined subsequently by market forces. Most of the empirical work on short-term capital flows is based on so-called fixed exchange rate systems in which there is an official commitment to buy or sell foreign exchange to keep its price within prescribed limits.

In this chapter we describe our model of the Canadian foreign exchange market operating under a pegged exchange rate system from 1Q63 until the Canadian dollar was floated in 2Q70. We believe that a realistic model of a pegged exchange rate system must explain the movements of both short-term capital and foreign exchange rates taking into account the interdependence of the private and official demand for foreign exchange. Although most of the usual studies are of short-term capital movements

(e.g. [6], [43], [52]), we estimate the private demand for foreign exchange. If trade and long-term capital flows are predetermined, as they usually are assumed to be in studies of short-term capital flows, the balance of payments identity can then be used to convert an estimate of short-term capital flows into an estimate of the change in reserves, or vice versa. The major difference between our approach and other approaches lies, therefore, not in the use of an equation determining the private demand for foreign exchange instead of an equation for private short-term capital movements, but in the use of separate equations for private demand and official demand that then interact to determine the exchange rate and the change in foreign exchange reserves.

In section B we describe the RDX2 equations for the foreign exchange market under a pegged exchange rate system. We conclude, in section C, with a discussion of our proposed method for determining the exchange rate and short-term capital flows under a flexible exchange rate system.

B The Foreign Exchange Market under Pegged Exchange Rates

The theory on which our model is based [27] applies equally to markets for foreign exchange of all delivery dates. For each market any number of separate demand equations may interact to determine an exchange rate and the change in the asset balance of each identified participant. In empirical application, however, one can estimate demand equations only where a substantial number

of market transactions are recorded in data series for quantities traded. Under a pegged exchange rate system, the change in official reserves may have sufficient variance to allow estimation of separate private and official demand equations for foreign exchange. It is more difficult to find promising series of the quantities of forward exchange traded. The foreign exchange authorities are not such regular participants in the market as are the private traders and even when official dealings are frequent the available data do not indicate the maturity structure of official forward exchange transactions. Thus we have been forced to represent the forward exchange market by a single reduced-form equation for the price of foreign exchange for 90-day delivery (PFXF). PFXF is measured in terms of the cost in Canadian dollars of one U.S. dollar.

Our model of the market for spot exchange consists of two excess demand equations and a market-clearing condition. These three equations can thus be solved, given the forward exchange rate, for the change in official reserves (FXO), the private demand for foreign exchange (FXP), and the spot price of foreign exchange (PFX).

FXO Official excess demand for spot exchange

(Equation 21.1)

This equation is our attempt to picture the process whereby the official foreign exchange reserves are managed in a system under which the exchange rate is pegged between two official support points. The behaviour modelled is that of the Canadian foreign exchange authorities, since it is they (and not the

foreign exchange authorities of the United States or some other country) who made the undertaking to maintain the exchange rate linking the Canadian and U.S. dollars. Thus it is the Canadian official purchases and sales of foreign exchange that provide the basic data on quantities traded. The equation must show how the official demand for reserves becomes infinite as the price of foreign exchange reaches its lower support point and the supply becomes infinite as the upper support point is approached. Between those two points there is room for other factors to come into play.

Our equation supposes that the official demand for foreign exchange is influenced by the target level of reserves (where applicable), a nonlinear approximation to the exchange rate rule, a variable reflecting additional willingness to support the Canadian dollar when it is weak, and a desire to 'test' the strength of the market at any time when the spot exchange rate moves through par. The exchange rate target (ZRESD), which applied from mid-1963 until 4Q68, was based on agreements between the U.S. government and the Canadian government. The two exchange rate variables are new to our current equations. The nonlinear variable is symmetric about 1.081, the midpoint of the permissible range of variation. It reaches plus infinity at 1.09 and minus infinity at 1.072. These extreme values are interpreted as the wholesale equivalent of retail prices at the permissible limits of 1% on either side of par. The second variable, reflecting asymmetry in exchange rate support policy, is always negative or equal to zero. It takes nonzero values only when the exchange rate is above 1.080, and these (negative)

values decrease linearly with the excess of the actual exchange rate over 1.080. The starting point for this variable was chosen after we experimented with a range of alternatives. In combination with the reserve target and the trading strategy variable, the two exchange rate variables explain 85% of the variance in the official demand for reserves. This is a substantial improvement in the fit of the model compared to the results from earlier experiments [27] using a shorter data period.

FXP Private excess demand for spot exchange
(Equation 21.1)

Private participants in the exchange market are assumed to be influenced by the volume of trade and long-term capital flows, the spot and forward prices of foreign exchange, the representative short-term interest rates in international centres, and the lagged stock of net short-term international liabilities. We have qualitative variables to represent the effects of the U.S. Interest Equalization Tax, and the speculative capital outflow from Canada in 1Q68 as well as the reversing inflow (assumed to be of equivalent size) in 2Q68. An additional variable accounting for the U.S. balance of payments guidelines was tried but it did not improve the fit of the RDX2 version of the FXP equation, although it appears in the 'pure flow' version reported in [31].

Collinearity among the various interest rates, between the spot exchange rate and forward exchange rate, and between most international interest rate differentials and the forward-spot

exchange rate differential forced us to impose some restraints on the generality of the model in order to obtain sensible parameter estimates. In particular, we constrained these variables to enter in the form of a covered interest rate differential, positive if in favour of Canada. We tried several experiments in which the interest rate differential and the forward exchange rate differential were allowed to have different effects, but the results were inferior to those of the constrained version. As a Canadian rate we use the short-term Government of Canada bond rate (RS). In an attempt to capture the changing relevance of domestic U.S. interest rates and the Euro-dollar rate, we developed a weighted average of the U.S. 90-day treasury bill rate (RTB2) and the 90-day London Euro-dollar deposit rate (REUR). The basic weights depend on the size of the Euro-dollar deposit market in relation to the U.S. time deposit market. In addition, further weight is attached to the Euro-dollar rate when it is high relative to the U.S. Certificate of Deposit rate (RCD2), i.e. when Regulation Q starts to hinder seriously the ability of U.S. banks to bid for domestic deposits. This very complex interest rate does not explain the sample period data any better than a simple Canadian-U.S. covered interest rate differential, but the complex rate is much better suited to explain the massive 1969 flows out of Canada to the Euro-dollar market.

To capture the influence of trade and long-term capital flows, the equation contains a two-quarter average of the trade and long-term capital balance and also the average of net short-term liabilities outstanding between Canada and the rest of the

world at the end of the two preceding quarters. The coefficients of -.22 on the trade balance variable and .13 on the cumulated short-term liabilities imply that any change in the trade balance will be half cleared through the foreign exchange market by the time one year has passed. The significant positive coefficient on the stock of short-term liabilities implies that any change in the trade balance will eventually lead to a corresponding purchase or sale of foreign exchange.

Since the long-term capital flow equations of RDX2 are based on the assumption that neither pure flow nor pure stock theories of capital movements can be correct in conditions of general portfolio growth, one may ask why the desired stock of short-term liabilities is not affected, in the FXP equation, by portfolio growth. The reason for the different approach in the foreign exchange market is that our short-term indebtedness figures are, unfortunately, net rather than gross. Gross claims, whether short- or long-term, of the residents of one country on residents of another country might well be a function of portfolio growth, but net claims are a different matter. The desired net short-term liability of one country to others is the linear difference between two growing series. This difference may or may not itself be growing, depending on the size, the rate of growth, and the equilibrium portfolio proportions in each of the countries. There is no presumption that the desired net short-term foreign liabilities should either grow or decline with growth of Canadian or foreign population, wealth, income, or trade.

The interest rate coefficients in the FXP equation suggest an inflow, in response to an increase of 1 percentage point in

the covered interest rate differential, of about $135 million in the first quarter, $220 million in the second quarter, $200 million in the third quarter, $170 million in the fourth quarter, and so on in diminishing amounts until the stock of short-term liabilities reaches a new equilibrium about $1,750 million higher than its initial position.

All one can tell from these single equation results is what the response would be to a given increase in the covered interest rate differential. To investigate the effects of an initial change in the uncovered interest rate differential, one must take account of induced changes in the forward exchange rate and the spot exchange rate. The effect on the forward rate can be deduced from its own equation, whereas the net impact on the spot rate can only be discovered when all the equations of the model are jointly solved.

PFXF The 90-day forward exchange rate (Equation 21.3)

This is a reduced-form equation, so it ought to include the determinants of both the private and official demand for forward exchange. The private demand is represented by a four-quarter moving average of the balance of trade and long-term capital flows, the interest rate differential, and variables reflecting the surge of speculative purchases in 1Q68. Since the official strategy of forward market operations is not governed by any easily specified rules, we have used instead the actual level of official purchases in the forward market as the measure of official demand. Assuming that the policy itself does not depend directly on the price (consistent estimation should reveal the

extent of this reverse influence), the coefficient tells how much the forward rate will alter as a result of a given quantity of official forward purchases in the current quarter.

The coefficient on the interest rate differential indicates that induced forward rate movements will directly offset slightly less than 60% of any increase in the covered interest rate differential induced by a change in interest rates. This is a partial effect, ignoring any repercussions through the spot exchange rate.

PFX Equilibrium condition in the foreign exchange market, used to determine the spot exchange rate, PFX (Canadian dollars per U.S. dollar) (Equation 21.4)

We postulate that the foreign exchange market clears continuously, and hence that the sum of private and official demand for foreign exchange equals zero. This assumption permits us to use the measured and adjusted series for the change in reserves as the dependent variable for both the private and official demand equations. The private demand equation implicitly 'explains' the behaviour of all private participants plus any governments outside Canada entering the Canadian foreign exchange market.

FIS Balance of payments identity used to determine short-term capital flows as a residual (Equation 21.5)

ULS Net international short-term liabilities outstanding between Canada and the rest of the world (Equation 21.9)

In equation 21.5 we apply the balance of payments identity to determine short-term capital flows (in millions of Canadian dollars) as the Canadian dollar equivalent of the official purchases of foreign exchange minus the balance on trade and long-term capital accounts.

Short-term capital flows (in millions of U.S. dollars) are accumulated in equation 21.9 for ULS.

URES Canadian foreign exchange reserves (Equation 21.8)

Here official reserves are shown as the cumulant of official purchases plus two variables (ERES1ADJ and ERES2ADJ) adjusting for some transactions that altered the level of reserves without influencing the foreign exchange market. (See [31] for a description of ERES1ADJ and ERES2ADJ.)

Forecasts and policy simulations using the model described above, and an alternative model based on a pure flow theory of private short-term capital movements, are reported in [31]. Both versions give fairly accurate solutions for both exchange rates and for the change in reserves during the twenty-four quarter fitting period. The version used in RDX2 has a root mean square error of the solution values for the spot exchange rate of .153 cents, about half the standard deviation of PFX during that period. Outside the fitting period, the stock-adjustment version used in RDX2 fares much better than the alternative pure flow version.

C The Foreign Exchange Market under Flexible Exchange Rates

The model described above is appropriate only for the period during which Canada was on a pegged exchange rate, 3Q62-1Q70. When using RDX2 for simulation in the adjacent periods of floating exchange rates, some alternative procedure must be developed.

Our theoretical model is equally applicable to fixed and floating exchange rate regimes (as shown in [27]), but empirical implementation is more difficult under a flexible exchange rate system. The fact that trade and long-term capital flows are influenced by the larger movements of a flexible rate raises no problems. It is merely necessary to solve the trade and long-term capital flow equations jointly with the private and official demand for foreign exchange. The main problem arises from the likelihood that the foreign exchange authorities are not very systematic traders in foreign exchange under a flexible rate system. As we have already noted, if little or no systematic official trading takes place, no suitable data exist on which to base our FXO and FXP equations.

In RDX1 we had an explicit equation for short-term capital flows, and treated the foreign exchange rate as exogenous. To leave a floating exchange rate unexplained is not desirable in a model designed to capture external influences. So we prefer to have a reduced-form equation for the exchange rate and to treat the change in foreign exchange reserves as an exogenous policy variable. This means that short-term capital flows would be obtained as a residual from the balance of payments identity.

CHAPTER 12

HOW THE MODEL WORKS

A Introduction

In this chapter we hope to make the model as a whole come to life by tracing a few of its main chains of causation, presenting the results from some preliminary simulations, and outlining the broader range of experiments now planned. We have developed programmes for data assembly, model estimation, and simulation that allow models as large as RDX2 to be handled with some facility. A substantial problem remains in grasping the extent and relative importance of the various interactions within the model. Lacking such a grasp, the user will work for the model rather than have the model work for him. All the benefits to be derived from a large quantitative model can only be realized when its basic mechanisms are understood and their relative importance is clearly established.

In section B we discuss a few of the model's mechanisms, and in section C we present some preliminary evidence of their relative importance. We outline in section D our plans for a more complete set of experiments designed to tell us about the model so that it can then tell us about the real economy.

B Some Chains of Influence

We shall use an increase in government expenditure to illustrate certain interesting features of RDX2. Some of the chains of influence mentioned here will be quantified by the results reported in the next section. Consider the effects of a sustained increase in federal government current nonwage expenditure (GCNWF). The lack of a specific assumption about how this expenditure will be financed implies that any resulting net use of funds will be met by increasing the supply of treasury bills (LGFTB). The immediate effect of such expenditure is to increase the aggregate demand variable UGPPA. Part of this increase in demand will be met by running down inventories (via their buffer-stock role), and the degree of utilization of capital and labour will increase (via increases in average weekly hours). There will also be some increase in employment. This increase in employment will lead to increases in total wages, partly because of small increases in the quarterly wage rate. The increase in UGPPA will produce upward pressure on various final demand prices, while the increase in short-term labour productivity will push in the opposite direction. Increases in UGPP and PGPP comprise an increase in their product YGPP. This causes corporate profits to increase, offset to some extent by the increase in business wage payments.

Increases in domestic prices and the rate of domestic capacity utilization cause imports to rise and exports to drop.

The supply price of capital (RHO) is subject to a number of conflicting forces. Both the increase in the supply of

government debt relative to real assets and the increase in profits cause the value of the business capital stock (VKB) to rise; the higher interest rate causes VKB to fall. RHO will fall if the value of the business capital stock rises proportionately more than after-tax profits. This condition is not exact, for it depends on induced changes in PCPICE.

In the government sector there will be increases in personal and corporate income taxes, along with increased revenues from other taxes and from the Unemployment Insurance Fund. Federal government employment in administration is decreased in the light of the decrease in the general unemployment rate, but offsetting upward pressures are generated by increases in real personal income. The net impact of these changes is likely to offset currently only a small part of the cost of the initial expenditure.

As for the initial increase in government debt, it will be lodged in private portfolios only if short-term and long-term interest rates on government debt increase, or if there is an expansion of the banking system. If we suppress the central bank reaction function, and suppose the monetary base to be constant, then higher interest rates on government debt will lead to higher interest rates on other liquid assets that are substitutes in private portfolios. Higher domestic interest rates will lead to short-term and possibly net long-term capital inflows (depending on whether RHO goes up or down), probably smaller in size than the induced trade deficit. If there is a net deficit on current and long-term capital account, the interaction of private and official demand for foreign exchange will lead to a higher price

of foreign exchange and a reduction of foreign exchange reserves. The latter development will further reduce net federal government borrowing requirements. The permanent income flowing from the increased market value of business capital may or may not increase depending on movements in the relevant rate of return (RHOR). Permanent income streams from stocks of durables and bonds will increase, however, as prices and interest rates rise, and YPDNWP will probably increase. Capital gains on equities will be offset by capital losses on bonds and it is not clear in what direction YKGP will move. Disposable wage income will increase, and we expect, on balance, to see some net induced increase in consumption which will amplify most of the reactions already mentioned.

During the second quarter of increased expenditure a number of the induced changes start to impinge on investment behaviour. Increases in prices and wages may lead to increases in the incentive to substitute capital for labour. This will be so if wage rates and investment goods prices increase by corresponding proportions in the first quarter because the expectations process for wage rates extrapolates further into the future than does the expectations process for capital goods prices. The incentive to substitute capital for labour will be sharpened if RHO has fallen or dulled if RHO has risen. At this point the increase in UGPPA finds its way into the investment process defining expected future output, and thus increasing investment via the flexible accelerator mechanism.

As sales continue to increase, the flexible accelerator mechanism in the inventory equation starts to play a stronger

role opposing the buffer-stock reduction, especially as greater employment and average weekly hours increase UGPPS, thereby reducing the incentive to draw down inventories. Furthermore, successive inventory reductions decrease the lagged stock of inventories below the desired level and thus make additional inventory cuts less likely.

Increases in non-residential construction lead to increases in employment, average hours, and the quarterly wage rate in construction. These cost increases in turn lead to upward pressure on the price deflators for residential and non-residential construction.

The combination of a lower unemployment rate and a higher real wage results in more immigration, less emigration, and a higher rate of labour force participation. All these factors reduce the cost and price pressures that are a consequence of the initial increase in aggregate demand.

By now we have followed the ripples out so far from the original splash that the size and direction of the resulting movement is difficult to trace. At this stage, there is little substitute for a direct examination of simulation evidence.

C Preliminary Simulation Results

1 Historical tracking within the sample period and ex post forecasts for 1969 and 1970.

In Tables 12.1 and 12.2 at the end of this chapter we present a record of the tracking qualities of the model. Two simulations are reported. The first is a twenty-one-quarter simulation (4Q63-4Q68) within the estimation period of the structural equations of the model. The second is an eight-quarter simulation initiated in 1Q69 and running to 4Q70, an 'ex post' forecast outside the sample period, employing historical values for all exogenous variables. The historical mean, the root mean squared error, and, where applicable, the root mean squared error as a percentage of the mean are reported for each variable in the two tables. Table 12.1 is composed of gross national expenditure and its principal components, in constant and in current dollars. Table 12.2 is made up of a selection of important variables from elsewhere in the model grouped under several sector-related headings.

Some rough measures of the goodness of fit of RDX2 in simulation can be adduced from these statistics. Looking at root mean squared errors as a percentage of the mean and at the 42 variables or aggregates of variables for which this measure has meaning, 25 in the intra-sample period and 15 in the post-sample period have values of less than 2%. A further 4 variables in the intra-sample period and 11 in the post-sample period have values of less than 3%. The average of the percentage errors for all 42

variables is 3.1% intra-sample and 4.05% post-sample. If one excludes the unemployment rate, which is notoriously difficult to predict accurately and in the prediction of which we fare little better than others, the average of the percentage errors falls to 2.63% within the sample period and to 3.48% in the post-sample period.

As has been found with most other large models, errors among components of aggregates tend to be offsetting. Thus our errors in constant- and current-dollar GNE are 1.07% and 1.01%, respectively, in the intra-sample simulation and 1.27% and 1.06%, respectively, in the post-sample period of eight quarters. A major exception in RDX2 is the absolute level of unemployment (NU). Labour force participation tends to be overstated when employment is understated and vice versa leading to uncomfortably large errors in the number unemployed and hence in the unemployment rate.

It can be seen that, with the notable exception of private investment expenditure, which remains remarkably well on track, most percentage errors are modestly larger in the post-sample simulation. This is to be expected. We are just beginning the examination of the sources of these errors and will have more to report later about the relative contribution to them of inadequate or shifting structure, measurement errors in variables, or the apparent emergence of new forces of which we have failed to take sufficient account. Given the slowdown of economic growth in early 1969 and the downturn of late 1969 and 1970, and given that we have made no effort as yet (with a single exception) to adjust the equations for some of the extraordinary

events of that period, we are not unhappy with the performance of RDX2. The single case in which we have felt compelled to adjust the structural equations of RDX2 arises because of our need to substitute in 1970 some alternative mechanism for our model of the foreign exchange market. For the purpose of this report we have simply exogenized the spot and forward exchange rates and the official and private demand for foreign exchange, and have used their actual 1970 values in our simulations.

2 Some representative shocks

In order to present an early report on some other dynamic properties of RDX2 we have conducted four simulation experiments of a straightforward character. With a twenty-nine-quarter control solution of the model (4Q63-4Q70) as a reference, we have examined the effects of the following four shocks.

(a) A fiscal policy

Federal government current nonwage expenditure (GCNWF) is raised by $100 million in 4Q63 by shifting the constant term of this equation and the shift is maintained until the end of the period. With no explicit assumption of alternative means of financing, the induced net use of funds is financed by the issue of additional treasury bills (LGFTB).

(b) A monetary policy

The Bank of Canada pursues an easier monetary policy through a lower interest rate target and the implicit provision of reserves to support this policy. We have lowered the constant term in the reaction function determining the short-term rate of interest (RS) by 50 basis points and maintained this shift throughout the period.

(c) A fiscal policy with restrictive monetary policy

Under the assumptions of our fiscal policy experiment, the central bank is willing to provide the reserves necessary to have the additional treasury bills absorbed in private or bank portfolios at the level of short-term interest rates yielded by the policy reaction equation. In order to examine fiscal multipliers under the assumption that the Bank of Canada is unwilling to provide such support but is determined to maintain the size of the banking system approximately unchanged (i.e. at its control solution) we have combined the two shocks above but have reversed the direction of the interest rate shift by raising the intercept of the reaction function by 50 basis points. This is a crude approximation to the action necessary to keep the banking system at its control solution size.

(d) An appreciation of the Canadian dollar

The Canadian dollar is assumed to appreciate by approximately 5% for one quarter and by approximately 7% thereafter. The Canadian price of a U.S. dollar (PFX) is

lowered to $1.03 in 4Q63, to $1.01 in 1Q64, and maintained at $1.01 until 2Q70 when it is lowered to $.97 and then in 3Q70 and 4Q70 to $.95. Throughout the period the private and official demand for foreign exchange (FXP and FXO) are set equal to their historical values.

Under the headings Fiscal, Monetary, Fiscal plus Monetary, and Appreciation, Table 12.3 (see pp.258-262) contains values of the induced effects of these shocks in the fourth quarter of seven successive years (i.e. 4Q64 to 4Q70). These values are reported for each variable or aggregate of variables that appears in Tables 12.1 and 12.2. Table 12.3 is organized similarly to Tables 12.1 and 12.2, with GNE and its components in constant dollars and current dollars followed by a selected set of variables grouped under several sectoral headings.

What, in general, can be said about these results? First, and rather unnerving for policy makers, there is the strong cyclical character of response. The combination of both capital and labour supply constraints and strong accelerator mechanisms in the model leads to rather sharp reductions in effect once the peak is passed. Indeed, ignoring timing differences between policies and between variables for the moment, peaks in effect are observable in the third to fourth years followed by substantial declines into the seventh year. Subsequent investigation leads us to believe that the trough of this cyclical process occurs in about the seventh year and that succeeding cycles of roughly the same periodicity slowly damp. Our early experimentation with the stationary state properties of

the model also leads us to believe that one may take the mean of the peak and trough over the first cycle as a very rough measure of the equilibrium effect. At the moment, however, this must be a very tentative guess.

Our practice of reporting fourth quarter values obscures somewhat the precise turning points and peak effects. In addition the tendency of peak effects on prices and wages to lag the peak effects on constant-dollar expenditure by approximately a year implies that peaks in current-dollar expenditure equations generally lag their real counterparts. If we focus upon real quantities, fiscal policy multipliers peak during the third year or in approximately twelve quarters, whereas monetary policy has its largest impact after about sixteen quarters of application. The combined policies not surprisingly are intermediate in timing. Appreciation has its maximum effect on reducing Canadian real income in the twelfth quarter. Fifty to seventy-five per cent of the short-run impact of these policies is felt in six quarters for fiscal policy, seven to eight quarters for monetary policy, and six quarters for the combined policies.

The impacts of these various policies appear uniformly stronger than those reported for RDX1 [32]. However several important differences in the structure of the two models should be noted. A very substantial proportion of government expenditure, exogenous to RDX1, has been endogenized in RDX2. More importantly, in RDX2 we go much further than RDX1 in integrating the real and financial sectors of the model and in spelling out the portfolio consequences of various spending decisions. Thus our fiscal policy entails substantial support on

the part of the monetary authorities and is therefore associated with substantial growth in the banking system accompanying the limited interest rate effects. Peak multipliers in the neighbourhood of 3 and 5.5 on constant- and current-dollar GNE, respectively, are accompanied by a banking system that is some 4% larger than control and a short-term interest rate (RS) that peaks only some 40 basis points above control. When this simulation is repeated in our fiscal plus monetary policy case, with the banking system restricted, RS rises by 95 basis points and the multipliers on constant- and current-dollar GNE are reduced to approximately 2.25 and 4, respectively. These multipliers are somewhat larger than those reported for RDX1, using a roughly comparable method of financing a fiscal policy change. (See Tables 1-3 in [32] or [33].)

The reader can pursue, through the vehicle of Table 12.3, additional analysis of the consequences of the policies we have chosen. It is our purpose to present here only an early indication of some of the emerging properties of RDX2. We shall be discussing these properties in greater length and detail in our forthcoming study, The Dynamics of RDX2.

We conclude with a few words about the appreciation simulation. An extensive analysis of this case has been presented elsewhere [26] and need not be elaborated here. We have made a modification to RDX2, not incorporated in the earlier experiments reported in [26]. We now take explicit account of the effects of exchange rate appreciation on the price of Canadian imports of goods from countries other than the United States (PMNTE13). Since the earlier experiments were primarily

concerned with the effects of appreciation on the Canadian bilateral balance with the United States this change is of small consequence to that paper. However, the change does modify the total consequences reported there.

The maximum reduction in real income occurs in the third year. Prices and wages move downward with a lag and do not reach their trough until the fifth year. As a result current-dollar GNE bottoms out in the fourth year. The appreciation leads to a first year fall in real exports of approximately $300 million, which remains relatively constant throughout the seven year period. The resulting current account deficit (XBAL$) is gradually offset until the third year by declining imports, and then is rapidly increased as imports rise with rising real income toward the end of the period. The net balance on current and long-term capital account (UBAL) diverges little from the current account deficit in the first year but then the deficit increases steadily as, in the early years, net capital inflows fall off in response to falling interest rates and borrowing requirements. In the later years some resumed net capital inflows serve to offset partially the growing current account deficit. It is noteworthy that, if our inference about equilibrium effects should be substantiated, the long-term consequence of Canadian dollar appreciation will be little change in Canadian real income and employment because of roughly equal proportionate reductions in domestic prices and money incomes.

D Further Simulation Plans

1 Policy simulation

RDX2 is loaded with policy instruments and various government reaction functions, and we plan to test the effectiveness of most of them both inside and outside the sample period. There are three basic model environments that can be used for these simulations, and we would like to try all three.

1.1 Historical context

This framework, which is the one we used for all our RDX1 simulations, is relatively easy to employ, since actual values are available for all the exogenous variables. However, as we found with our tests of the dynamic efficiency of automatic stabilizers [30], the simulation consequences of a policy change depend heavily on the values taken by various other exogenous variables. Thus it is difficult to disentangle the consequences over time of a hypothetical policy change from the particular features of the historical data underlying the simulation. The other two types of simulation get around this problem in different ways.

1.2 Forecasting context

If one wishes to assess the likely consequences of policy choices made at the present time, and if those consequences

depend heavily on the values of the exogenous variables, the simulations are best performed within a genuine forecasting context. This requires that 'best guesses' be used for all the exogenous variables. For longer run simulations, most of the exogenous variables will have fairly smooth profiles in the absence of specific information.

1.3 Stationary context

The best way to abstract the policy simulations from a particular period of history is to define a set of exogenous variables from which all variance has been removed. The dynamic consequences of either cyclical or sustained shocks applied to RDX2 could be assessed much more precisely by using a special set of exogenous variables constructed for the purpose. Such a procedure would not work in a model with important nonhomogeneities, so we hope that our emphasis on both stock and flow disequilibrium adjustment processes has made RDX2 a suitable vehicle for this kind of simulation.

We would also like to run stochastic simulations of the three varieties described above, taking account of uncertainty about exogenous variables, parameter estimates, and equation residuals. Although we recognize that the size of RDX2 will severely limit the feasible scope of stochastic simulations, we shall do what we can.

2 Linked simulations

RDX2 has been designed so that it can be linked with models of other countries, particularly with a U.S. model. Thus we are able and anxious to undertake a variety of simulations of RDX2 with the MPS model, a recent variant of the FRB-MIT-Penn model ([1], [14], [50]). These simulations will be described in detail elsewhere, as they are part of a separate project (see [36]). Such experiments may provide the most accurate measures of the results attainable from various Canadian policies. At the very least, they will allow some precise assessment of the effects on Canada of alternative economic developments abroad. By fitting both Canadian and U.S. models with policy reaction functions that take the balance of payments into account, we should be able to get a better idea of what sets of national decisions are mutually consistent within a world environment.

To say much more at this stage might take us too far beyond where we are now. Here is RDX2. We expect to report again on its progress before too many months have passed.

TABLE 12.1

INTRA-SAMPLE AND POST-SAMPLE MEANS, ROOT MEAN SQUARED ERRORS AND ROOT MEAN SQUARED ERROR AS PER CENT OF MEAN OF GROSS NATIONAL EXPENDITURE AND COMPONENTS

(CONSTANT 1961 DOLLARS)

		INTRA-SAMPLE 4Q63-4Q68			POST-SAMPLE 1Q69-4Q70	
	MEAN	RMSE	%RMSE	MEAN	RMSE	%RMSE
Personal Consumption Expenditure C = (CNDSD+CS+CMV+CDO)	8144.0	70.4	.86	9557.1	228.1	2.39
Government Current Expenditure GC = [(GCNWF+GCNWPM+GCGSH)/PGCNWG+EG61MPF+1434.0285 NIS+1297.1399 NGPAF+ 921.23014 NGPAPM+603.68732 (GWIF+GWIPM)/WQIOS]	1927.0	24.1	1.24	2309.6	104.9	4.54
Gross Investment						
Government IG = [IH+IIG+INRCGF+INRCGPM+INRCSM+IMEGF+IMEGPM]	556.7	22.3	4.0	614.6	23.2	3.78
Private Fixed I = (IME+INRC+IRC)	2498.7	138.2	5.5	2847.0	46.1	1.62
Business Inventories IIB	-	104.9	-	-	191.5	-
Exports of Goods and Services X	2942.9	36.7	1.25	4112.3	126.4	3.07
Imports of Goods and Services M	3129.6	84.0	2.69	4150.9	105.6	2.54
Gross National Expenditure UGNE	13141.0	140.2	1.07	15553.0	197.3	1.27
(CURRENT DOLLARS)						
Personal Consumption Expenditure C$ = (CNDSD)(PCNDSD)+(CS)(PCS)+(CMV)(PCMV)+(CDO)(PCDO)	9002.8	88.4	.98	11940.7	332.3	2.78
Government Current Expenditure GC$ = [GCNWF+GCNWPM+GCGSH+GMPF+(NIS)(WQISM)+(NGPAF)(WQGPAF)+ (NGPAPM)(WQGPAPM)+GWSSM+GWPASPM+GWSF+GWIF+GWIPM]	2417.3	34.9	1.44	3685.2	89.7	2.43
Gross Investment						
Government IG$ = [IH(PIH)+IIG$+(INRCGF+INRCGPM+INRCSM)(PINRCG)+ (IMEGF+IMEGPM)(PIMEG)]	657.6	64.2	9.77	788.0	101.7	12.9
Private Fixed I$ = (IME)(PIME)+(INRC)(PINRC)+(IRC)(PIRC)	2862.7	145.3	5.08	3612.4	60.7	1.68
Business Inventories IIB$ = J1D[(PKIB)(KIB)]+YIVA	-	112.1	-	-	239.1	-
Exports of Goods and Services X$ = X$12+X$13-XIH$-XTRP$	3278.6	46.3	1.41	4967.0	219.5	4.42
Imports of Goods and Services M$ = M$12+M$13-MIH$-MTRP$-GTNRF+TWF	3446.7	92.3	2.68	4940.0	137.4	2.78
Gross National Expenditure YGNE	15004.1	151.7	1.01	20378.5	215.9	1.06

TABLE 12.2

INTRA-SAMPLE AND POST-SAMPLE MEANS, ROOT MEAN SQUARED ERRORS AND ROOT MEAN SQUARED ERROR AS PER CENT OF MEAN OF SELECTED VARIABLES

	INTRA-SAMPLE 4Q63-4Q68			POST-SAMPLE 1Q69-4Q70		
	MEAN	RMSE	%RMSE	MEAN	RMSE	%RMSE
Components of Gross National Product						
YW	7860.3	74.6	0.95	11280.8	201.2	1.78
YC	1676.6	135.6	8.09	1902.0	240.3	12.63
TILGS	1987.8	41.8	2.10	2737.3	60.6	2.22
Monetary Sector and Interest Rates						
ABT	19782.5	634.9	3.21	27955.4	1871.9	6.70
ANFCUR+DDB	7397.1	290.9	3.93	8736.8	275.2	3.15
ANFLIQ	50819.1	678.2	1.34	65705.1	1466.4	2.23
RS	5.14	0.40	7.73	7.07	0.74	10.52
RL	5.71	0.18	3.20	7.76	0.38	4.89
RHOR	6.60	0.29	4.33	6.63	0.32	4.82
V	172162.2	2911.5	1.69	218549.2	5217.9	2.39
Government Sector						
GBALF	-	68.8	-	-	95.4	-
GBALPM	-	42.9	-	-	79.1	-
LGFTB	1840.6	203.9	11.08	2638.5	511.5	19.39
LGBPM	17413.1	127.3	0.73	22875.0	182.0	0.80
External Trade and Balance of Payments						
XBAL$	-	117.8	-	-	254.6	-
X$12	2094.0	21.2	1.01	3405.6	174.5	5.13
M$12	2482.1	69.6	2.81	3493.1	97.2	2.78
UBAL	-	142.8	-	-	440.8	-
UBAL12	-	121.1	-	-	232.5	-
FXO	-	79.3	-	-	98.8	-
PFX	1.078	.002	0.22	-	-	-
Employment and Labour Force						
NMMOB	4.092	.033	0.82	4.626	.097	2.11
NE	7.079	.053	0.75	7.830	.078	1.00
NL	7.393	.033	0.44	8.268	.082	1.00
NPOP	13.470	.029	0.22	14.827	.035	0.23
RNU	4.26	.84	19.75	5.31	1.31	24.61
Wages and Prices						
WQMMOB	1289.0	9.91	0.77	1602.3	5.0	0.31
PGNE	1.136	.008	0.72	1.310	.014	1.11
PCPI	1.114	.007	0.62	1.276	.014	1.10
PCPICE	2.007	.223	11.09	3.454	.214	6.20
Output Measures						
UGPP	11497.2	134.2	1.17	13787.8	188.6	1.37
UGPPA	11475.9	150.9	1.32	13638.7	281.7	2.07
UGPPS	11457.8	84.6	0.74	14111.7	136.0	0.96
UGPPD	11382.7	61.0	0.54	14275.5	177.4	1.24

TABLE 12.3

EFFECTS IN SUCCESSIVE FOURTH QUARTERS
OF FOUR REPRESENTATIVE SHOCKS ON
GROSS NATIONAL EXPENDITURE AND COMPONENTS

(CONSTANT 1961 DOLLARS)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
C	Millions'61$							
Fiscal		74.6	124.1	141.2	110.0	47.0	-19.8	-40.3
Monetary		28.8	44.5	54.9	48.8	28.1	-12.2	-36.1
Fiscal + Monetary		47.1	84.3	96.4	76.6	41.0	27.4	40.8
Appreciation		.6	-24.2	-10.2	31.8	119.4	210.3	267.4
GC	Millions'61$							
Fiscal		92.0	88.4	87.2	84.7	82.9	81.8	80.6
Monetary		1.5	.2	-	1.3	.1	-.5	-1.1
Fiscal + Monetary		90.4	88.5	88.2	85.4	86.1	87.2	87.2
Appreciation		8.2	13.8	23.0	26.1	28.7	27.5	29.8
IG	Millions'61$							
Fiscal		4.4	5.6	11.6	13.0	8.3	.2	-4.0
Monetary		3.9	4.9	8.6	10.8	5.7	-.6	-2.9
Fiscal + Monetary		0.7	1.7	4.1	3.3	4.3	4.1	2.8
Appreciation		-2.2	-2.5	-7.2	-2.4	-.8	2.9	9.1
I	Millions'61$							
Fiscal		64.4	128.9	170.4	127.0	17.8	-108.5	-169.8
Monetary		44.4	61.4	71.3	62.5	9.4	-52.1	-84.3
Fiscal + Monetary		22.4	70.7	105.5	71.4	20.2	-37.9	-61.2
Appreciation		-19.6	-78.1	-135.9	-124.4	-8.6	134.9	241.7
IIB	Millions'61$							
Fiscal		16.6	21.4	22.5	-3.5	-16.4	-16.1	4.9
Monetary		2.2	3.9	2.2	0.7	-6.7	-8.3	1.7
Fiscal + Monetary		14.5	16.4	20.8	-4.0	-8.3	-7.7	3.6
Appreciation		2.7	-43.9	-34.7	-13.0	5.8	21.7	-8.8
X	Millions'61$							
Fiscal		-4.8	-9.0	-9.5	-7.9	-4.5	1.2	5.4
Monetary		-	-1.8	-1.3	-0.7	0.8	3.3	4.6
Fiscal + Monetary		-4.9	-7.3	-8.2	-7.0	-4.1	-0.7	0.5
Appreciation		-72.8	-71.2	-64.7	-64.5	-70.2	-76.2	-95.0
M	Millions'61$							
Fiscal		62.2	101.9	130.9	92.8	19.0	-47.4	-43.0
Monetary		15.7	26.9	33.1	22.8	-7.9	-47.9	-54.2
Fiscal + Monetary		46.7	75.5	100.8	75.1	37.0	14.6	28.0
Appreciation		37.5	-.9	-11.7	12.6	93.4	190.1	208.6
UGNE	Millions'61$							
Fiscal		185.1	257.4	292.3	230.6	116.0	-13.9	-80.5
Monetary		65.1	86.1	102.7	100.6	45.3	-22.6	-64.0
Fiscal + Monetary		123.4	178.7	206.0	150.5	102.4	57.9	45.6
Appreciation		-120.5	-205.2	-218.0	-159.0	-19.0	131.0	235.7

(CURRENT DOLLARS)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
C$	Millions$							
Fiscal		86.3	181.8	258.9	281.1	238.7	145.6	76.6
Monetary		32.4	63.6	97.3	113.2	108.7	63.4	16.1
Fiscal + Monetary		54.3	119.4	165.9	177.7	150.5	122.8	118.1
Appreciation		-46.8	-120.3	-177.5	-205.7	-153.4	-41.9	69.8
GC$	Millions$							
Fiscal		113.8	126.1	137.6	144.2	141.6	135.5	127.8
Monetary		3.4	6.5	10.2	15.6	15.1	11.8	6.6
Fiscal + Monetary		110.0	118.4	126.6	129.7	130.8	130.2	128.8
Appreciation		-.5	-3.7	-4.9	-10.6	-7.7	-.3	15.8
IG$	Millions$							
Fiscal		5.7	7.8	14.7	15.4	9.3	-.1	-4.9
Monetary		4.6	6.0	10.2	12.5	6.5	-.2	-3.5
Fiscal + Monetary		1.4	2.7	5.7	4.1	4.7	4.2	3.0
Appreciation		-9.3	-11.7	-18.9	-12.7	-9.5	-5.2	.1

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
I$	Millions$							
Fiscal		84.2	178.2	245.4	203.6	66.7	-95.2	-180.3
Monetary		52.6	80.8	98.7	94.6	29.6	-49.0	-94.5
Fiscal + Monetary		33.6	99.0	151.5	114.6	50.3	-21.4	-53.0
Appreciation		-53.1	-143.0	-235.9	-231.5	-86.8	90.0	226.3
IIB$	Millions$							
Fiscal		28.5	35.8	34.9	-4.0	-27.7	-28.7	1.0
Monetary		8.8	8.2	6.7	3.3	-10.6	-13.7	-1.7
Fiscal + Monetary		19.5	25.8	28.6	-7.0	-14.6	-13.1	4.4
Appreciation		-15.9	-63.6	-51.7	-19.0	15.4	32.5	-7.0
X$	Millions$							
Fiscal		-2.8	-2.8	-.2	4.6	9.4	14.7	17.1
Monetary		2.1	2.2	3.6	6.6	8.0	15.2	11.3
Fiscal + Monetary		-4.7	-5.3	-4.2	-1.8	2.6	4.8	5.6
Appreciation		-124.1	-134.3	-138.2	-146.4	-164.2	-179.3	-214.5
M$	Millions$							
Fiscal		68.0	112.6	146.4	106.9	24.0	-53.7	-49.1
Monetary		18.9	32.1	38.5	28.5	-9.7	-52.9	-67.3
Fiscal + Monetary		49.8	81.3	111.3	84.6	45.2	19.7	38.0
Appreciation		-53.4	-106.0	-136.0	-110.1	-19.3	82.9	81.0
YGNE	Millions$							
Fiscal		250.5	421.1	557.9	554.6	428.9	237.3	95.2
Monetary		85.7	137.7	192.4	223.6	172.7	84.0	4.1
Fiscal + Monetary		166.3	283.4	370.6	342.3	287.9	216.2	176.2
Appreciation		-193.8	-371.4	-496.6	-524.8	-395.6	-192.9	10.0

EFFECTS OF SHOCKS ON SELECTED OTHER VARIABLES

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
Components of Gross National Product								
YW	Millions$							
Fiscal		95.6	197.2	287.0	327.4	273.2	163.8	57.1
Monetary		29.6	67.7	101.0	129.7	118.7	72.6	18.4
Fiscal + Monetary		64.4	125.5	183.4	200.1	165.6	114.5	76.3
Appreciation		-69.3	-169.0	-265.9	-318.6	-273.7	-158.5	-26.3
YC	Millions$							
Fiscal		132.9	183.1	214.0	173.7	115.2	53.1	31.1
Monetary		47.2	55.0	69.5	69.6	33.7	-.5	-18.0
Fiscal + Monetary		88.5	131.7	151.3	111.3	98.4	85.6	86.6
Appreciation		-108.4	-169.2	-183.7	-161.9	-92.8	-28.7	20.3
TILGS	Millions$							
Fiscal		13.5	28.5	42.1	40.5	31.4	15.9	4.7
Monetary		5.9	11.2	17.0	19.2	17.3	11.1	4.6
Fiscal + Monetary		7.7	17.4	25.6	22.5	16.8	10.1	7.6
Appreciation		-9.2	-21.9	-33.8	-32.0	-21.1	-2.6	15.2
Monetary Sector and Interest Rates								
ABT	Millions$							
Fiscal		382.5	489.1	645.1	797.7	746.1	645.5	479.5
Monetary		532.5	628.0	756.5	972.0	886.0	1020.5	845.1
Fiscal + Monetary		-135.2	-89.5	-73.9	-121.4	-48.7	-65.5	-227.0
Appreciation		-33.4	-122.3	-471.5	-450.4	-180.2	-344.1	-465.0
ANFCUR+DDB	Millions$							
Fiscal		170.7	142.3	157.5	186.4	157.1	139.8	167.6
Monetary		323.5	357.4	418.2	527.6	509.5	557.5	717.1
Fiscal + Monetary		-155.1	-190.6	-243.3	-323.9	-341.1	-381.5	-564.9
Appreciation		-40.6	-34.6	-120.3	-222.8	-146.2	-183.6	-312.6
ANFLIQ	Millions$							
Fiscal		559.2	873.4	1072.5	1210.1	1334.1	1492.0	1946.0
Monetary		296.1	429.9	456.2	461.2	376.1	114.7	618.6
Fiscal + Monetary		321.8	495.6	660.6	817.4	1185.5	1815.2	2016.5
Appreciation		-61.3	401.2	691.1	700.0	1425.2	2247.5	2566.9

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
RS	Percentage Points							
Fiscal		.13	.30	.25	.18	.07	-.16	-.24
Monetary		-.64	-.58	-.71	-.76	-.73	-.90	-.93
Fiscal + Monetary		.78	.87	.97	.93	.81	.76	.72
Appreciation		-.14	-.20	-.36	-.34	.00	.11	.16
RL	Percentage Points							
Fiscal		.04	.10	.15	.22	.23	.14	.02
Monetary		-.18	-.27	-.39	-.50	-.56	-.62	-.68
Fiscal + Monetary		.22	.37	.54	.71	.78	.77	.72
Appreciation		-.06	-.10	-.22	-.28	-.25	-.20	-.09
RHOR	Percentage Points							
Fiscal		.23	.30	.34	.24	.10	-.04	-.10
Monetary		-.04	-.07	-.15	-.21	-.32	-.41	-.48
Fiscal + Monetary		.27	.37	.49	.45	.42	.36	.37
Appreciation		-.16	-.36	-.43	-.42	-.30	-.15	-.15
V	Millions$							
Fiscal		1774.2	3254.7	4433.7	4768.3	4168.9	3332.3	3270.6
Monetary		1371.7	2569.0	3621.1	4645.8	5188.5	4869.4	5462.6
Fiscal + Monetary		469.2	879.0	1119.7	605.1	-97.5	40.2	-114.8
Appreciation		-630.5	-1206.0	-1458.6	-876.9	883.9	3071.6	4993.0
Government Sector								
GBALF	Millions$							
Fiscal		-47.0	-12.9	.5	-17.0	-52.0	-101.8	-136.7
Monetary		25.7	38.2	48.7	53.1	43.2	29.5	12.9
Fiscal + Monetary		-72.7	-51.8	-48.3	-70.9	-97.5	-134.7	-151.8
Appreciation		-53.9	-105.6	-133.3	-129.4	-102.7	-54.6	-22.5
GBALPM	Millions$							
Fiscal		-5.7	-10.8	-11.8	-7.0	6.1	19.5	23.6
Monetary		-4.6	-9.0	-11.0	-12.8	-6.4	2.7	4.8
Fiscal + Monetary		-.7	-1.7	-.8	4.8	11.6	17.3	19.8
Appreciation		2.8	7.4	13.4	.6	-8.1	-19.5	-24.8
LGFTB	Millions$							
Fiscal		317.5	344.6	357.2	344.1	450.1	764.5	1188.6
Monetary		-145.9	-313.9	-493.1	-729.3	-1075.0	-1227.2	-1354.4
Fiscal + Monetary		465.9	667.3	853.3	1105.2	1721.3	2413.1	2949.3
Appreciation		46.2	374.1	632.1	996.6	1370.1	1498.5	1387.0
LGBPM	Millions$							
Fiscal		5.8	41.2	84.4	117.7	111.2	48.1	-42.7
Monetary		20.6	50.3	91.1	141.5	177.0	178.8	164.4
Fiscal + Monetary		-15.1	-10.1	-7.9	-22.6	-61.3	-126.9	-207.0
Appreciation		-5.3	-25.0	-71.2	-93.1	-65.7	-7.4	88.3
External Trade and Balance of Payments								
XBAL$	Millions$							
Fiscal		-69.4	-113.3	-143.6	-99.0	-11.2	71.3	68.4
Monetary		-16.8	-29.8	-35.1	-22.7	15.9	65.2	74.0
Fiscal + Monetary		-53.1	-84.3	-112.2	-82.3	-37.2	-8.8	-25.3
Appreciation		-72.5	-31.2	-5.9	-40.2	-149.7	-266.5	-298.9
X$12	Millions$							
Fiscal		1.1	2.8	3.7	3.0	.2	-1.7	-1.6
Monetary		1.9	3.0	4.0	4.8	4.3	4.8	1.3
Fiscal + Monetary		-.8	-.2	-.1	-1.3	-2.4	-3.0	-2.2
Appreciation		-91.4	-93.7	-95.7	-97.8	-100.3	-98.3	-112.8
M$12	Millions$							
Fiscal		51.3	84.8	108.6	72.9	3.1	-59.8	-50.3
Monetary		14.7	24.9	29.1	20.2	-11.4	-46.4	-54.4
Fiscal + Monetary		37.2	60.4	82.4	58.0	23.9	3.0	19.0
Appreciation		-34.6	-76.4	-95.3	-72.0	5.2	90.3	81.6

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
UBAL	Millions$							
Fiscal		-81.4	-82.9	-63.6	2.6	76.9	78.2	13.7
Monetary		-49.1	-49.7	-47.5	-60.9	-11.4	9.9	-12.0
Fiscal + Monetary		-31.4	-37.0	-21.8	56.1	70.2	41.9	8.2
Appreciation		-85.0	-73.2	-84.9	-183.0	-326.0	-271.2	-254.2
UBAL12	Millions$							
Fiscal		-64.1	-58.8	-40.1	8.9	64.2	59.5	7.4
Monetary		-41.6	-37.8	-32.9	-48.3	-4.3	8.5	-10.9
Fiscal + Monetary		-21.5	-24.2	-11.5	51.8	53.7	27.7	6.4
Appreciation		-66.4	-51.0	-57.7	-137.4	-244.5	-174.4	-152.3
FXO	MillionsUS$							
Fiscal		5.1	18.3	-4.9	-4.9	7.8	15.0	0
Monetary		15.5	25.8	-6.5	-11.0	-58.5	126.4	0
Fiscal + Monetary		1.5	-6.2	1.5	20.6	93.4	30.0	0
Appreciation		91.8	-18.0	54.2	43.5	-71.8	339.1	0
PFX	$C/$US							
Fiscal		.001	.002	.002	.002	.000	.000	.000
Monetary		.002	.003	.002	.003	.001	.004	.001
Fiscal + Monetary		-.001	-.001	-.000	-.001	.000	-.001	.000
Appreciation		-.066	-.066	-.066	-.065	-.063	-.063	-.070
Employment and Labour Force								
NMMOB	Millions							
Fiscal		.046	.081	.100	.087	.049	.001	-.030
Monetary		.013	.027	.033	.033	.020	-.002	-.020
Fiscal + Monetary		.034	.056	.071	.060	.037	.016	.007
Appreciation		-.030	-.068	-.084	-.071	-.029	.029	.069
NE	Millions							
Fiscal		.056	.094	.115	.099	.054	-.003	-.042
Monetary		.018	.034	.042	.043	.026	-.001	-.024
Fiscal + Monetary		.038	.062	.079	.065	.039	.015	.004
Appreciation		-.035	-.076	-.095	-.077	-.024	.043	.092
NL	Millions							
Fiscal		.013	.038	.069	.096	.103	.083	.040
Monetary		.002	.011	.022	.033	.039	.032	.015
Fiscal + Monetary		.010	.027	.048	.066	.071	.061	
Appreciation		-.002	-.018	-.042	-.066	-.073	-.052	-.003
NPOP	Millions							
Fiscal		.001	.015	.041	.071	.092	.090	.064
Monetary		.000	.004	.014	.026	.036	.038	.031
Fiscal + Monetary		.001	.011	.027	.047	.060	.057	.042
Appreciation		.000	-.008	-.028	-.058	-.080	-.079	-.051
RNU	Percentage Points							
Fiscal		-.624	-.794	-.647	-.088	.559	.995	.980
Monetary		-.230	-.327	-.277	-.134	.140	.395	.477
Fiscal + Monetary		-.406	-.503	-.434	-.014	.370	.528	.409
Appreciation		.466	.822	.740	.166	-.590	-1.154	-1.170
Wages and Prices								
WQMMOB	Dollars							
Fiscal		3.2	9.1	16.4	24.6	28.1	26.7	20.9
Monetary		.8	2.8	5.6	9.2	11.6	12.0	10.3
Fiscal + Monetary		2.0	5.4	9.6	14.2	15.7	14.1	10.6
Appreciation		-5.0	-12.2	-23.2	-34.5	-41.3	-41.8	-36.7
PGNE	1961 = 1.000							
Fiscal		.004	.010	.016	.019	.019	.016	.013
Monetary		.001	.003	.005	.007	.008	.007	.006
Fiscal + Monetary		.003	.006	.009	.011	.011	.009	.007
Appreciation		-.005	-.011	-.018	-.024	-.025	-.023	-.019

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
PCPI	1961 = 1.000							
Fiscal		.001	.007	.013	.018	.020	.018	.0
Monetary		.000	.002	.005	.007	.008	.008	.0
Fiscal + Monetary		.001	.004	.007	.010	.011	.009	.0
Appreciation		-.006	-.012	-.020	-.027	-.031	-.030	-.0
PCPICE	Percentage Points							
Fiscal		.026	.107	.204	.376	.383	.232	.0
Monetary		.007	.037	.073	.137	.164	.117	.0
Fiscal + Monetary		.016	.063	.119	.221	.208	.120	-.0
Appreciation		-.006	-.012	-.020	-.027	-.031	-.030	-.0
Output Measures								
UGPP	Millions'61$							
Fiscal		183.2	259.2	294.0	229.4	111.7	-20.6	-85.7
Monetary		63.6	86.0	102.4	98.5	42.6	-26.5	-67.7
Fiscal + Monetary		123.0	180.1	206.9	150.9	100.0	53.6	42.2
Appreciation		-120.6	-208.3	-221.9	-164.3	-24.4	130.0	233.5
UGPPA	Millions'61$							
Fiscal		210.3	278.4	294.1	208.6	73.6	-61.8	-113.7
Monetary		77.9	94.3	106.5	96.4	29.4	-44.6	[illegible]
Fiscal + Monetary		137.0	192.8	205.1	134.5	77.8	35.9	33.8
Appreciation		-149.4	-218.7	-214.4	-133.7	30.4	182.4	278.5
UGPPS	Millions'61$							
Fiscal		108.1	196.5	270.9	279.1	210.8	84.8	-29.8
Monetary		31.5	64.5	91.0	103.0	77.8	21.2	-36.8
Fiscal + Monetary		78.4	136.1	189.7	191.5	156.5	100.2	57.0
Appreciation		-60.4	-141.6	-204.8	-216.3	-149.3	-3.5	143.7
UGPPD	Millions'61$							
Fiscal		49.7	123.7	213.0	280.7	285.4	210.4	85.1
Monetary		8.9	35.1	65.7	91.8	93.3	71.5	19.6
Fiscal + Monetary		41.3	89.5	151.1	198.1	203.8	165.3	103.3
Appreciation		-15.1	-67.6	-142.2	-212.9	-229.6	-145.9	2.8

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No. 7

BANK OF CANADA
STAFF RESEARCH STUDIES

THE STRUCTURE OF RDX2

PART 2

1971

JOHN F. HELLIWELL
HAROLD T. SHAPIRO
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ISSUED BY THE PUBLICATIONS COMMITTEE OF THE BANK OF CANADA

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This study was prepared as part of the econometric research programme of the Research Department of the Bank of Canada. The views expressed are those of the authors and no responsibility for them should be attributed to the Bank.

CONTENTS

APPENDIX A

ALPHABETICAL LIST OF VARIABLES USED IN RDX2

All the Canadian variables used in RDX2 have mnemonic titles that follow a naming scheme developed for RDX2. This scheme is based on procedures suggested for use in Project LINK [1], and is intended to ease the problems of linking various national models. Since RDX2 has much more detail in its balance of payments, financial, and government sectors than is allowed for in these sectors of the Project LINK models, we have substantially extended and modified the Project LINK procedures to suit our purposes. However, we are planning to link RDX2 to a recent version of the MPS model (formerly known as the FRB-MIT-Penn model) and are using data from that model as the source of all U.S. variables appearing in RDX2. Thus all these variables bear the names assigned to them in the MPS model. For inclusion in RDX2, such names have the numeral 2 appended to warn the reader that the RDX2 naming scheme does not apply to these variables.

The dominant principle in the RDX2 mnemonic system is that

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the first letter of a variable indicates its general role in the model and how the variable is measured. Descriptions of our first-letter classification follow, exceptions being noted under the relevant letter.

A is a financial asset at book value measured in millions of dollars.

C is a consumption expenditure measured in millions of 1961 dollars.
- CPVME is present tax value of depreciation allowances for machinery and equipment.
- CPVNR is present tax value of depreciation allowances for non-residential construction.

D is a deposit in a financial institution measured in millions of current dollars.
- An appended B indicates a bank deposit.

E is an exogenous, quantitative variable, but of various units.

F is an international capital flow measured in millions of current dollars. (FI is an inflow and FO is an outflow.)
- FX is an excess demand for spot exchange.

G is a government expenditure, transfer payment, or balance item measured in millions of current dollars.
- G...F is federal government.
- G...PM is combined provincial and municipal governments.

H is a mortgage loan approval measured in millions of current dollars.
- HAW is average weekly hours.
- HST is housing starts measured in thousands per quarter.

I is an investment expenditure measured in millions of 1961 dollars.

J is an operator. The J is always followed either by a numeral or by W. The numeral refers to the number of quarters, including the current quarter, involved in the operation. The following operations are defined in a case where J is followed by some

numeral.

J3A is a three-quarter unweighted moving average starting in the current quarter.

J3D is a three-quarter difference.

J3L is a three-quarter lag.

J3P is a three-quarter percentage change.

J3S is a three-quarter moving sum.

The JW operator is a weighted moving average (or an unweighted moving average not starting in the current quarter). The weights are listed under the equation in which the operator is used. If the weights are estimated by a polynomial distributed lag technique, then the absolute values of the t-statistics are shown beside the weights. If the weights have been specified a priori, then the estimated coefficient and t-statistic are shown in the equation. The variable to which the J operator applies is shown in parenthesis immediately behind the operator.

K is real capital, net of depreciation, measured in millions of 1961 dollars.

KMEY is a desired capital/output ratio for machinery and equipment.

KNRY is a desired capital/output ratio for non-residential construction.

L is a financial liability at book value measured in millions of current dollars.

M is imports measured in millions of 1961 dollars.

N is persons measured in millions.

NHH is in thousands.

P is a price or price index with a 1961 base value of 1.

PFX is the exchange rate measured in Canadian dollars per U.S. dollar.

Q is a seasonal or dummy variable.

R is an interest rate, tax rate, or other rate always defined as per cent per annum.

S is a stock of an asset measured in units.

T is a tax revenue measured in millions of current dollars.

TR is a transfer from persons to governments.

U is an endogenous variable not otherwise classified.

V is the market value of some A, L, K, or S variable measured in millions of current dollars. V alone is private sector wealth, or net worth, measured at market value in millions of dollars.

W is a wage rate measured in current dollars.

X is exports measured in millions of 1961 dollars.

Y is an income item measured in millions of current dollars.

Z is an exogenous monetary or fiscal policy variable.

When numbers appear at the end of a variable they refer to countries. Thus 1 refers to Canada, 2 refers to the United States, and 3 refers to other countries. When two numbers appear at the end of a variable the first one indicates the country to which the variable refers. Thus X12 represents trade flows from Canada to the United States measured in millions of 1961 dollars. Variables are measured in terms of the currency of the 'actor' country. For example L12 is a liability of Canada to the United States measured in millions of current Canadian dollars. The variable L21 would represent the same debt seen as a U.S. asset, and therefore measured in terms of current U.S. dollars. A dollar sign appearing as part of a variable indicates that the variable is the current-dollar value of a constant-dollar variable. For example IIG$ is the current-dollar value of the constant-dollar variable IIG.

There are 588 variables in RDX2. Of these, 265 are endogenous and 323 are exogenous. In addition to the mnemonic and the description for each variable, the list of variables contains the RDX2 tape number for every entry as well as the

equation number in the case of the endogenous variables. There are two ways of distinguishing the endogenous and exogenous variables of RDX2. Each variable endogenous to RDX2 has an equation number (e.g. 9.11 indicates the eleventh equation in Sector 9), and a simulator coding number preceded by X. Each variable exogenous to RDX2, whether or not the variable is endogenous to the U.S. model, has a simulator coding number prefixed by E, but no equation number.

Eight exceptions to this rule should be noted. Although ABELNF, IMEGF, IMEGPM, NEUPB, PCMV, PXMV12, WQISM and YNFNC have simulator coding numbers in the X series these variables are in fact exogenous to RDX2. (In Appendix B we show the equation for PCMV (7.3), but, since PCMV is treated as exogenous to RDX2, equation 7.3 has not been coded in the simulator.)

For the most part the model data are available on tape as quarterly time series. However, a number of variables are on the RDX2 tape as monthly series and must be converted to quarterly series when used in the model. Use of the monthly series is indicated in the variable list by an RDX2 tape number that includes a final numeral in brackets. For example the RDX2 tape number for ABBCD is B255(9). A (7), (8) or (9) indicates the nature of the conversion: a (7) indicates that the quarterly data are the sum of the monthly data, an (8) that the quarterly data are an average of the months, and a (9) that the quarterly data are equal to the data of the last month of the quarter. The RDX2 tape number also gives a clue to the status within the

MPS model of the U.S. variables we use. All numbers in the range FM1 to FM200 are drawn from the MPS list of endogenous variables, whereas numbers in the range FM201 and up are taken from the MPS list of exogenous variables.

All RDX2 data are seasonally unadjusted. All MPS data are seasonally adjusted, with flow variables at annual rates.

ALPHABETICAL LIST OF VARIABLES USED IN RDX2

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
A12	11879	20.7	X=1	Book value of U.S. indebtedness to Canada, including retained earnings accruing to Canadian shareholders
A13	11880	20.8	X=2	Book value of the indebtedness of other countries to Canada, including retained earnings accruing to Canadian shareholders
ABBCD	B255(9)	16.7	X=13	Bank of Canada deposits held by chartered banks
ABBCN	B252(9)	16.2	X=14	Bank of Canada notes held by chartered banks
ABEC	BS621(8)		E=199	Excess cash reserves held by chartered banks on a statutory basis
ABEL	BS601	16.8	X=3	Chartered bank earning liquid assets
ABELCD	BS602	16.9	X=4	Chartered bank Canadian dollar earning liquid assets
ABELNF	B1809(9)	See p. v	X=5	Chartered bank net foreign assets
ABLB	BS603	16.6	X=6	Chartered bank business and miscellaneous general loans
ABLGBPM	BS606		E=237	Chartered bank holdings of provincial and municipal direct and guaranteed bonds
ABLM	BS605		E=236	Chartered bank mortgage loans
ABLO	BS604		E=108	Other loans held by chartered banks
ABLP	B1405(9)	16.5	X=9	Chartered bank personal loans
ABSC	B619(9)		E=2	Corporate securities held by chartered banks

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
ABSTATN	B803(9)	16.3	X=16	Bank of Canada notes held by chartered banks on a statutory basis
ABT	BS600	16.10	X=10	Chartered bank total assets
ALI	BS123		E=104	Assets of life insurance companies
ANFCUR	B2010(9)	15.1	X=15	Currency outside chartered banks held by non-financial public
ANFGN	BS380	15.9	X=11	Government of Canada, provincial and municipal debt less chartered bank day, call and short loans held by nonfinancial public
ANFLIQ	BS381	15.10	X=12	Liquid assets held by nonfinancial public
APLLI	BS109		E=114	Life insurance company policy loans
ATL	14676	17.11	X=267	Assets of trust and loan companies
AYCRE12	11895		E=4	Retained earnings accruing to Canadian shareholders from U.S. corporations
AYCRE13	11896		E=5	Retained earnings accruing to Canadian shareholders from corporations in other countries
CCA$	D40010		E=240	Capital consumption allowances
CCAC$	3711		E=187	Capital consumption allowances, corporations
CCAGF$	D40100		E=217	Capital consumption allowances, federal government
CCAGH$	D40103		E=228	Capital consumption

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				allowances, hospitals
CCAGPM$	13645		E=227	Capital consumption allowances, provincial and municipal governments
CDO	11377	1.4	X=18	Consumer expenditure on durables (excluding motor vehicles and parts)
CMV	11375	1.3	X=19	Consumer expenditure on motor vehicles and parts
CNDSD	14636	1.1	X=20	Consumer expenditure on non-durables and semi-durables
CPVME	11985		E=273	Present tax value of depreciation allowances, machinery and equipment
CPVNR	11986		E=274	Present tax value of depreciation allowances, non-residential construction
CS	D40213	1.2	X=21	Consumer expenditure on services
CSMVOD	11752	1.7	X=22	Imputed consumer services from the stock of motor vehicles and other consumer durables
DCDPB	BS370	15.11	X=24	Canadian dollar deposits in chartered banks (excluding Government of Canada deposits)
DDB	BS371	15.5	X=25	Demand deposits in chartered banks (excluding float, Government of Canada deposits and personal chequing accounts)
DDGFB	B652(9)		E=92	Government of Canada demand deposits in chartered banks
DNPTB	B655(9)	15.7	X=27	Nonpersonal term and notice deposits in chartered banks

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
DPB	BS372	15.2	X=28	Personal savings and personal chequing accounts in chartered banks
DSTATB	B806(9)	16.1	X=29	Statutory deposits in chartered banks
DSTL	14666	15.3	X=261	Chequable and non-chequable demand and savings deposits in trust and loan companies
DSWPB	BC2605	15.6	X=30	Swapped deposits in chartered banks
DTTL	14665	15.8	X=260	Receipts and guaranteed investment certificates deposited in trust and loan companies
EACR	13607		E=275	Weighted average coupon rate for Government of Canada direct market issues
EACR1C	13603		E=252	Weighted average coupon rate for Government of Canada direct market issues, maturity class 1
EACR2C	13604		E=253	Weighted average coupon rate for Government of Canada direct market issues, maturity class 2
EACR3C	13605		E=254	Weighted average coupon rate for Government of Canada direct market issues, maturity class 3
EACR4C	13606		E=255	Weighted average coupon rate for Government of Canada direct market issues, maturity class 4
EACRCSB	13665		E=276	Weighted average coupon rate for Canada Savings Bonds
EATM1C	13660		E=256	Average term-to-maturity

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				of Government of Canada direct market issues, maturity class 1
EATM2C	13661		E=257	Average term-to-maturity of Government of Canada direct market issues, maturity class 2
EATM3C	13662		E=258	Average term-to-maturity of Government of Canada direct market issues, maturity class 3
EATM4C	13663		E=259	Average term-to-maturity of Government of Canada direct market issues, maturity class 4
EC2	FM6		E=149	U.S. consumer expenditure on durables (1958 dollars)
EC$2	FM52		E=261	U.S. consumer expenditure on durables (current dollars)
ECCA63A	13649		E=67	Variable to capture effects on taxable corporate profits of accelerated depreciation allowances introduced in 1963
ECCA66R	13650		E=68	Variable to capture effects on taxable corporate profits of reduced depreciation allowances introduced in 1966
ECINT	3745		E=110	Interest payments on Canadian corporate bonds and debentures
ECO2	FM44		E=43	U.S. personal consumption expenditure (1958 dollars)
ECO$2	FM51		E=41	U.S. personal consumption expenditure (current dollars)
EDO	13542		E=172	Average consumption of diesel oil (million

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				gallons per registered commercial motor vehicle)
EDTCA	13545		E=173	Variable to allow for overstatement of TCA and TCAF due to the use of a weighted marginal rather than a weighted average tax rate
EF68E	13709		E=7	Foreign exchange crisis expectations variable, 1.0 in 1Q68, -1.0 in 2Q68, zero elsewhere
EG61MPF	13523		E=85	Military pay and allowances (1961 dollars)
EGAS	13541		E=170	Average gasoline consumption (million gallons per registered noncommercial motor vehicle)
EGUIDE	13708		E=8	U.S. balance of payments guidelines variable
EIADJ	14663		E=313	Investment adjustment entry
EIET	13707		E=9	Interest equalization tax variable
EIETB	14652		E=290	Variable to reflect deferral of new corporate, provincial and municipal bond issues in the United States because of uncertainty about the exemption of such issues from the U.S. interest equalization tax. Uncertainty ended when the exemption became law and deferred deliveries took place in 4Q64; -.2 from 3Q63 to 3Q64 inclusive, +1.0 in 4Q64, zero elsewhere
EIFDMIS	13666		E=277	Miscellaneous components of interest on federal public debt

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
ELEFF	14624		E=272	Labour efficiency factor
EMEDPAY	13680		E=320	Provincial medicare payments (current dollars)
ENARES	D40237		E=84	National accounts expenditure residual
ENARES$	D40031		E=90	National accounts expenditure residual (current dollars)
ENT1C	11302		E=111	Proportion of total tax returns filed by taxpayers with assessed incomes between $0 and $3,000
ENT2C	11303		E=112	Proportion of total tax returns filed by taxpayers with assessed incomes between $3,000 and $5,000
ENT3C	11304		E=113	Proportion of total tax returns filed by taxpayers with assessed incomes between $5,000 and $10,000
EP68E	13710		E=10	Foreign exchange crisis support variable, 1.0 in 1Q68, zero elsewhere
EPD2	FM20		E=80	U.S. expenditure on producers durables (1958 dollars)
EPD$2	FM49		E=316	U.S. expenditure on producers durables (current dollars)
EPFXE	14606		E=189	Normal exchange rate. Prior to 2Q61 equals 1.0, from 3Q61 to 3Q62 equals PFX, from 4Q62 forward equals 1.081
EPOP	13818		E=307	The proportion of total population (NPOPT) in the labour force population (NPOP)
EPS2	FM19		E=70	U.S. expenditure on

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				producers structures (1958 dollars)
EPS$2	FM50		E=317	U.S. expenditure on producers structures (current dollars)
ERBCRDD	BS632		E=200	Required cash reserve ratio for chartered bank demand deposits (per cent)
ERBPCA	BS631		E=201	Ratio of personal chequing deposits to total personal deposits (per cent)
ERDO	13540		E=171	Weighted average provincial diesel oil tax rate (dollars per gallon)
ERES1ADJ	13706		E=11	Adjustment variable used to convert published foreign exchange reserve series to a stock the first difference of which is an accurate measure of FXO. Variable is based on Bank of Canada deposit liabilities plus sterling bond retirements in 1963, and is used in balance of payments statistics
ERES2ADJ	14660		E=182	Second adjustment variable used to convert published foreign exchange reserve series to a stock the first difference of which is FXO. Variable is based on IMF technical drawings, and is not used in balance of payments statistics
ERGAS	13539		E=169	Weighted average provincial gasoline tax rate (dollars per gallon)
ERMEDPM	13538		E=93	Weighted average rate of medical care insurance premiums

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
ERPAF	13667		E=291	Variable to redistribute federal retroactive wage payments made from 2Q69 to 1Q70
ERTIMVPM	13526		E=167	Weighted average provincial rate of licence fee for registered commercial motor vehicles (dollars per vehicle)
ERTPHPM	11995		E=115	Weighted average hospital insurance premium
ERTPMVPM	11998		E=162	Weighted average provincial rate of licence fee for registered noncommercial motor vehicles (dollars per vehicle)
ERUIB	11248		E=183	Weighted rate of maximum unemployment insurance benefit (dollars per week)
ESAEC2	14620		E=262	Seasonal adjustment factor for U.S. consumer expenditure on durables (EC$2)
ESAX02	14621		E=267	Seasonal adjustment factor for U.S. gross national product (XOBE$2)
ESUR	13674		E=279	Amount of surcharge that would have been collected had the 1961 volume of goods imports been maintained throughout the surcharge period 2Q62-1Q63
EWEURO	14661		E=177	Index of the real wage rate in Great Britain, Italy and West Germany (1961=1.0)
EWLF	13507		E=99	Ratio of resident-held Government of Canada direct market issues (excluding treasury bills) to resident-held total Government of

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				Canada, provincial and municipal direct market issues
EYDIVA11	13514		E=116	Ratio of assessed dividend income to total dividends paid to Canadians by Canadian corporations
EYNWAS1C	13591		E=117	Proportion of assessed nonwage income earned by taxpayers with assessed nonwage incomes between $0 and $3,000
EYNWAS2C	13592		E=118	Proportion of assessed nonwage income earned by taxpayers with assessed nonwage incomes between $3,000 and $5,000
EYNWAS3C	13593		E=119	Proportion of assessed nonwage income earned by taxpayers with assessed nonwage incomes between $5,000 and $10,000
EYWAS1C	13587		E=151	Proportion of assessed wage income earned by taxpayers with assessed wage incomes between $0 and $3,000
EYWAS2C	13588		E=152	Proportion of assessed wage income earned by taxpayers with assessed wage incomes between $3,000 and $5,000
EYWAS3C	13589		E=153	Proportion of assessed wage income earned by taxpayers with assessed wage incomes between $5,000 and $10,000
FIBL13	11886	19.11	X=31	Sales of Canadian corporate bonds and shares in other countries. Gross new issues, less retirements, plus net trade in outstanding

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				bonds and shares
FIDI12	D51560	19.1	X=32	Direct investment in Canada from the United States
FIDI13	13734	19.2	X=33	Direct investment in Canada from other countries
FIGB13	11885	19.10	X=34	Sales of Government of Canada, provincial and municipal bonds in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds
FILO12	11897		E=12	Other long-term capital inflows from the United States
FILO13	11898		E=13	Other long-term capital inflows from other countries
FINIB12	2030	19.6	X=35	Sales of gross new issues of Canadian corporate bonds in the United States
FINIGF12	11888		E=14	Sales of gross new issues of Government of Canada bonds in the United States
FINIPM12	11882	19.5	X=36	Sales of gross new issues of provincial and municipal bonds, direct and guaranteed, in the United States
FIPVB12	11884	19.9	X=37	Purchases of Canadian corporate shares on a portfolio basis by U.S. residents. Gross new issues, less retirements, plus net trade in outstanding shares
FIRETB12	2071		E=15	Retirements of Canadian corporate bonds held in the United States

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
FIRETG12	11889		E=16	Retirements of Government of Canada, provincial and municipal bonds held in the United States
FIS	9139	21.5	X=40	Net inflow of private short-term capital
FITOBB12	1992	19.8	X=38	Trade in outstanding Canadian corporate bonds between Canada and the United States (net sales to the United States)
FITOGB12	11883	19.7	X=39	Trade in outstanding Government of Canada, provincial and municipal bonds between Canada and the United States (net sales to the United States)
FIYCRE12	11869	19.13	X=262	Canadian corporate retained earnings accruing to U.S. shareholders
FIYCRE13	14681		E=203	Canadian corporate retained earnings accruing to residents of other countries
FODI12	13735	19.3	X=41	Direct investment from Canada in the United States
FOL13	11881	19.4	X=42	Long-term direct and portfolio investment in bonds and shares from Canada in other countries
FOPL12	11887	19.12	X=43	Purchases of U.S. bonds and shares by Canadians. Gross new issues, less retirements, plus net trade in outstanding bonds and shares
FXO	13704	21.1	X=44	Official excess demand for spot exchange

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
FXP	13700	21.2	X=45	Private excess demand for spot exchange
GALPM	13531		E=159	Changes in asset and liability accounts of provincial and municipal governments
GAMIS	13508		E=17	Changes in miscellaneous asset and liability accounts of the Government of Canada
GASSTF	13643		E=18	Federal capital assistance to industry
GASSTPM	D40129		E=224	Provincial capital assistance to industry
GBALF	13535	14.6	X=46	Federal national accounts balance (+ if surplus)
GBALH	D40172	14.8	X=259	Hospital national accounts balance (+ if surplus)
GBALPM	11999	14.7	X=47	Provincial-municipal national accounts balance (+ if surplus)
GBCPPPM	13529		E=160	Provincial bonds purchased by Canada Pension Plan Investment Fund
GBRETSPM	13530		E=105	Retirements of provincial and municipal bonds
GBRPM	13528	14.11	X=48	Gross new issues of provincial and municipal bonds (excluding provincial issues to Canada Pension Plan Investment Fund)
GCGSH	D40116		E=208	Current expenditure on goods and services by hospitals
GCNWF	11954	12.3	X=256	Federal current nonwage expenditure

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
GCNWPM	11965	13.4	X=257	Provincial-municipal current nonwage expenditure
GGSDF	D40113		E=308	Current defence expenditure on goods and services
GMPF	D40001		E=19	Military pay and allowances
GSUBSF	D40125		E=20	Federal subsidies
GSUBSPM	D40126		E=21	Provincial-municipal subsidies
GTGHPM	13644		E=225	Provincial-municipal transfers to hospitals
GTGMP	D40089		E=295	Provincial transfers to municipalities
GTGPMF	13642		E=22	Federal transfers to provinces and municipalities
GTNRF	D40130		E=218	Federal transfers to non-residents
GTPINTF	D40132	11.5	X=51	Interest on the federal public debt
GTPINTPM	13646		E=23	Provincial-municipal interest payments to persons
GTPOF	11991		E=24	Other federal transfers to persons
GTPPM	13537		E=25	Provincial-municipal transfers to persons
GTPUIBF	D1235(7)	11.2	X=52	Unemployment insurance benefits
GWIF	11961		E=26	Federal wages, salaries and supplements paid to employees in non-commercial institutions
GWIPM	11953		E=27	Provincial and municipal wages, salaries and supplements paid to employees in non-commercial institutions

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				(excluding schools)
GWPASPM	11967		E=210	Provincial and municipal wage supplements paid to employees in public administration
GWSF	11950		E=29	Federal wage supplements paid to employees in public admini- stration and defence
GWSSM	11932		E=211	Municipal wage supple- ments paid to employees in elementary and secondary schools
HAPB	BS1611(7)		E=98	Mortgage loans approved by chartered banks
HAPCMHCM	11371		E=120	Direct NHA loans approved by CMHC for multiple dwellings
HAPCMHCS	11370		E=96	Direct NHA loans approved by CMHC for single-detached dwellings
HAPLI	BS1632	17.10	X=266	Life insurance company mortgage approvals
HAPTL	14675	17.9	X=265	Trust and loan company mortgage approvals
HAWC	11836	5.4	X=55	Average weekly hours worked in construction
HAWMM	11850	5.3	X=56	Average weekly hours worked in mining and manufacturing
HSTM	14647	2.3	X=57	Housing starts, multiples (thousand units)
HSTS	14646	2.2	X=96	Housing starts, single- detached (thousand units)
IH	13637		E=207	Investment expenditure by hospitals

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
IIB	D40230	3.3	X=61	Change in nonfarm business inventories
IIF	D40231		E=31	Change in farm inventories
IIF$	D40028		E=88	Change in farm inventories (current dollars)
IIG	D40229		E=221	Value of physical change in government inventories
IIG$	D40026		E=220	Value of physical change in government inventories (current dollars)
IME	D40225	3.1	X=62	Business investment in machinery and equipment
IMEGF	13625	See p. v	X=253	Federal investment in machinery and equipment
IMEGPM	13632	See p. v	X=254	Provincial-municipal investment in machinery and equipment
INRC	D40224	3.2	X=63	Business investment in non-residential construction
INRCGF	13624	12.4	X=249	Federal investment in non-residential construction
INRCGPM	13631	13.5	X=250	Provincial-municipal investment in construction (excluding schools)
INRCSM	13629	13.6	X=251	Municipal investment in school construction
IRC	D40223	2.1	X=64	Business investment in residential construction
KB$	14688	18.7	X=73	Replacement value of business capital stock
KDO	13780	1.6	X=65	Stock of consumer durables (excluding motor vehicles)

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
KIB	11636	3.6	X=66	Stock of nonfarm business inventories
KME	11309	3.4	X=67	Stock of machinery and equipment
KMEY	11315	3.7	X=68	Desired capital/output ratio for machinery and equipment
KMV	13781	1.5	X=69	Stock of consumer motor vehicles
KNRC	11314	3.5	X=70	Stock of non-residential construction
KNRCGF	13668	12.5	X=225	Stock of federal non-residential construction
KNRCSM	13672	13.8	X=201	Stock of elementary and secondary schools
KNRY	11311	3.8	X=71	Desired capital/output ratio for non-residential construction
LCB12	11890	20.2	X=74	Canadian corporate bonds and debentures held by U.S. residents
LDIPRV13	14684	20.5	X=269	Replacement value of the stock of direct and portfolio investment in Canada by other countries, including Canadian corporate retained earnings accruing to shareholders of other countries
LDIRV12	14683	20.4	X=268	Replacement value of the stock of U.S. direct investment in Canada, including Canadian corporate retained earnings accruing to U.S. direct investors
LEURO	13712		E=234	Amount of short-term Euro-dollar liabilities reported by banks

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				in eight European countries
LF2+LA2	FM143		E=310	U.S. labour force, including armed forces
LGB12	11855	20.1	X=76	Government of Canada, provincial and municipal bonds, direct and guaranteed, held by U.S. residents
LGB13	11856	20.6	X=77	Government of Canada, provincial and municipal bonds, direct and guaranteed, held by residents of other countries
LGBF	13506		E=95	End-of-quarter stock of Government of Canada direct market issues held by the general public and the chartered banks
LGBFG	B2401(9)		E=106	Government of Canada guaranteed debt
LGBFR1C	11903		E=100	End-of-quarter stock of Government of Canada direct market issues 0-3 years held by the resident general public and the chartered banks
LGBFR2C	11904		E=101	End-of-quarter stock of Government of Canada direct market issues 3-5 years held by the resident general public and the chartered banks
LGBFR3C	11905		E=102	End-of-quarter stock of Government of Canada direct market issues 5-10 years held by the resident general public and the chartered banks
LGBFR4C	11906		E=103	End-of-quarter stock of Government of Canada

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				direct market issues 10 years and over held by the resident general public and the chartered banks
LGBPM	13505	14.12	X=78	End-of-quarter stock of provincial and municipal bonds, direct and guaranteed (excluding provincial issues to Canada Pension Plan Investment Fund)
LGFCSB	B2406(9)	15.4	X=263	End-of-quarter stock of Canada Savings Bonds
LGFTB	13664	14.9	X=26	End-of-quarter stock of Government of Canada treasury bills (excluding Bank of Canada holdings)
LGFTBNR	13513		E=107	End-of-quarter stock of Government of Canada treasury bills held by non-residents
LONB	BS379		E=198	Total liabilities of chartered banks, net of deposit liabilities
LONTL	14677		E=109	Other liabilities of trust and loan companies
LPCV12	14686	20.3	X=72	Value of common and preferred Canadian corporate shares held by U.S. residents
LU2	FM124		E=311	U.S. unemployment
M	14637	4.27	X=81	Imports of goods and services
M$12	13730	4.23	X=82	Imports of goods and services from the United States (current dollars)
M$13	13731	4.25	X=83	Imports of goods and services from other

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				countries (current dollars)
MCM12	11729	4.3	X=84	Imports of crude materials from the United States (SITC 2, 4)
MDIV$12	3721	4.17	X=86	Dividend payments to the United States
MEF12	11730	4.2	X=99	Imports of energy fuels from the United States (SITC 3)
MFB12	11728	4.1	X=87	Imports of food and beverages from United States (SITC 0, 1)
MFS$12	D51537	4.19	X=89	Freight and shipping payments to the United States
MFS$13	13783	4.22	X=90	Freight and shipping payments to other countries
MG	14673	4.30	X=157	Imports of goods
MID$13	13784	4.20	X=91	Interest and dividend payments to other countries
MIH$	D50540		E=42	Imports. Inheritances and emigrants' funds to all countries
MINT$12	3717	4.16	X=92	Interest payments to the United States
MMF12	11731	4.4	X=93	Imports of manufactures (excluding transportation equipment) from the United States (SITC 5-8 [excluding transportation equipment])
MMIS12	13834		E=32	Imports of transportation equipment (excluding motor vehicles and parts) and unclassified commodity transactions (SITC 9) from the United States plus

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				miscellaneous adjusting entries
MMIS13	13835		E=33	Imports of transportation equipment (excluding motor vehicles and parts) and unclassified commodity transactions (SITC 9) from other countries plus miscellaneous adjusting entries
MMV12	11742	4.5	X=95	Imports of motor vehicles and parts from the United States
MMV13	11743		E=40	Imports of motor vehicles and parts from other countries
MNTE13	14632	4.6	X=88	Imports of goods (excluding transportation equipment and unclassified commodity transactions [SITC 9]) from other countries (SITC 0-8 [excluding transportation equipment])
MOS$12	14630		E=155	Imports of other services from the United States
MOS$13	14631		E=157	Imports of other services from other countries
MTM$2	FM114		E=235	Total time deposits in member banks of the U.S. federal reserve system
MTR$12	D51531	4.18	X=101	Travel payments to the United States
MTR$13	13790	4.21	X=102	Travel payments to other countries
MTRP$	D40053		E=30	Transfer payments from Canadian residents to persons abroad
N2	FM205		E=179	Total U.S. population
NBIRTHS	13813		E=294	Births

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
NC	11835	5.2	X=103	Paid employees in construction
NCL	11247	11.4	X=104	Claimants on the Unemployment Insurance Fund
NDEATHS	13814		E=306	Deaths
NE	11824	5.10	X=105	Total employed persons (excluding armed forces)
NEMS	13816	5.7	X=185	Emigrants
NEMPS	11246	11.6	X=106	Employed contributors to the Unemployment Insurance Fund
NEUPB	11846	See p. v	X=128	Unpaid employees in non-farm business
NEUPF	14602		E=35	Unpaid farm workers
NFP	13723		E=34	Paid farm workers
NGPAF	11922	12.1	X=107	Federal employment in public administration and defence
NGPAPM	11962	13.1	X=108	Provincial-municipal employment in public administration
NHH	3054		E=286	Number of families in Canada
NIMS	13815	5.6	X=176	Immigrants
NINS	11257	11.3	X=109	Enrollment in the Unemployment Insurance Fund
NIOS	11829		E=36	Paid workers in non-commercial institutions (excluding schools)
NIS	11927	13.3	X=110	Employment in elementary and secondary schools under municipal control
NL	11141	5.5	X=111	Labour force
NMMOB	13851	5.1	X=112	Paid employees in mining, manufacturing and other business
NMMOBD	14653	5.12	X=215	Desired level of employ-

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				ment in mining, manufacturing and other business
NOAPR	13519		E=122	Old age pension recipients
NPOP	13817	5.9	X=224	Noninstitutional population 14 years of age and over
NPOPS	11931		E=296	Students enrolled in elementary and secondary schools
NPOPSS	11396		E=285	Total population 14 years of age and over attending school
NPOPT	13812	5.8	X=214	Total population (beginning-of-quarter figure)
NT	11544	9.7	X=114	Tax rèturns filed
NT1C	11545	9.10	X=115	Tax returns filed, income class 1
NT2C	11546	9.11	X=116	Tax returns filed, income class 2
NT3C	11547	9.12	X=117	Tax returns filed, income class 3
NT4C	11548	9.13	X=118	Tax returns filed, income class 4
NTNW1C	13569	9.26	X=123	Nonwage earners tax returns filed, income class 1
NTNW2C	13570	9.27	X=124	Nonwage earners tax returns filed, income class 2
NTNW3C	13571	9.28	X=125	Nonwage earners tax returns filed, income class 3
NTNW4C	13572	9.29	X=126	Nonwage earners tax returns filed, income class 4
NTW1C	13565	9.22	X=119	Wage earners tax returns filed, income class 1

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
NTW2C	13566	9.23	X=120	Wage earners tax returns filed, income class 2
NTW3C	13567	9.24	X=121	Wage earners tax returns filed, income class 3
NTW4C	13568	9.25	X=122	Wage earners tax returns filed, income class 4
NU	11063	5.11	X=127	Total unemployed persons
NX	11848		E=37	Employment residual
ODG2	FM294		E=66	U.S. military prime contracts for defence goods
PC2	FM131		E=263	Implicit price deflator for U.S. consumer expenditure on durables
PCDO	13799	7.4	X=129	Price of other consumer durables
PCMV	13791	7.3 (See p.v)	X=131	Price of consumer motor vehicles
PCNDSD	13792	7.1	X=130	Price of consumer non-durables and semi-durables
PCON2	FM132		E=312	Implicit price deflator for total U.S. consumption expenditure
PCPI	14642	7.20	X=132	The Consumer Price Index
PCPICE	11819	18.2	X=244	Expected annual rate of change in the Consumer Price Index
PCS	13793	7.2	X=133	Price of consumer services
PCSMVOD	14654	7.23	X=100	Implicit price deflator for imputed consumer services from the stocks of motor vehicles and of other consumer durables
PEEX2	FM206		E=283	Implicit price deflator

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				for U.S. exports
PEGF2	FM275		E=281	Implicit price deflator for U.S. federal purchases of goods and services
PFX	13702	21.4	X=134	Spot exchange rate (Canadian dollars per U.S. dollar)
PFXF	13703	21.3	X=135	90-day forward exchange rate (Canadian dollars per U.S. dollar)
PGCNWG	13500	7.17	X=137	Price deflator for government current nonwage expenditure
PGNE	13794	7.21	X=136	Price deflator for gross national expenditure
PGPP	11689	7.22	X=138	Price deflator for gross private business product
PI2	FM168		E=282	Implicit price deflator for U.S. stock of inventories
PIH	13640		E=226	Price deflator for hospital investment
PIME	13796	7.5	X=140	Price deflator for business investment in machinery and equipment
PIMEG	13639	7.19	X=255	Price deflator for government investment in machinery and equipment
PINRC	13797	7.7	X=141	Price deflator for business investment in non-residential construction
PINRCG	13638	7.18	X=252	Price deflator for government investment in non-residential construction

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
PIRC	13798	7.6	X=242	Price deflator for private investment in residential construction
PKIB	13811	7.8	X=243	Price of the nonfarm business inventory stock
PL2	FM152		E=297	Employee compensation rate in U.S. nonfarm private domestic business
PLGF1C	11913	14.2	X=142	Ratio of market value to book value of Government of Canada direct market issues, maturity class 1
PLGF2C	11914	14.3	X=143	Ratio of market value to book value of Government of Canada direct market issues, maturity class 2
PLGF3C	11915	14.4	X=144	Ratio of market value to book value of Government of Canada direct market issues, maturity class 3
PLGF4C	11916	14.5	X=145	Ratio of market value to book value of Government of Canada direct market issues, maturity class 4
PLGI	13511	14.10	X=146	Market valuation ratio for Government of Canada, provincial and municipal bonds held by Canadian residents
PMCM12	12531	7.14	X=59	Price index for imports of crude materials from the United States (SITC 2, 4)
PMCM13	11738		E=49	Price index for imports of crude materials from other countries (SITC 2, 4)
PMEF12	12530	7.15	X=60	Price index for imports of energy fuels from the United States (SITC 3)

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
PMEF13	11739		E=250	Price index for imports of energy fuels from other countries (SITC 3)
PMFB12	12528	7.13	X=58	Price index for imports of food and beverages from the United States (SITC 0, 1)
PMFB13	11737		E=251	Price index for imports of food and beverages from other countries (SITC 0, 1)
PMMF12	11741	7.16	X=94	Price index for imports of manufactures (excluding transport- ation equipment) from the United States (SITC 5-8 [excluding transportation equipment])
PMMF13	11740		E=278	Price index for imports of manufactures (excluding transport- ation equipment) from other countries (SITC 5-8 [excluding trans- portation equipment])
PMMIS12	13831		E=45	Price index for imports of transportation equipment (excluding motor vehicles and parts) and unclassified commodity transactions (SITC 9) from the United States plus miscellaneous adjust- ing entries
PMMIS13	13831		E=46	Price index for imports of transportation equipment (excluding motor vehicles and parts) and unclassified commodity transactions (SITC 9) from other countries plus miscel- laneous adjusting entries
PMMV12	12305		E=47	Price index for imports

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				of motor vehicles and parts from the United States
PMMV13	12305		E=48	Price index for imports of motor vehicles and parts from other countries
PMNTE13	14627		E=28	Price index for imports of goods (excluding transportation equipment, and unclassified commodity transactions [SITC 9]) from other countries (SITC 0-8 [excluding transportation equipment])
PMS	13848		E=51	Price index for imports of services
PNRM	14669	7.10	X=147	Price index for non-residential construction materials
POBE2	FM130		E=268	Implicit price deflator for U.S. gross national product (XOBE$2)
PPD2	FM133		E=97	Implicit price deflator for U.S. expenditure on producers durables (EPD2)
PPS2	FM141		E=94	Implicit price deflator for U.S. expenditure on producers structures (EPS2)
PRM	14670	7.9	X=148	Price index for residential construction materials
PWXG	9575		E=271	Price index for world exports of goods
PXB2	FM129		E=303	Implicit price deflator for U.S. gross private domestic business product (XB2)
PXBNF2	FM156		E=269	Implicit price deflator for U.S. nonfarm business product and household output

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
PXFP	12402		E=39	Price index for exports of forest products
PXMIS12	13840		E=79	Price index for exports of uranium and aircraft and parts to the United States plus miscellaneous adjusting entries
PXMIS13	13840		E=82	Price index for exports of uranium and aircraft and parts to other countries plus miscellaneous adjusting entries
PXMV12	12524	See p. v	X=149	Price index for exports of motor vehicles and parts to the United States
PXNMV12	11775	7.11	X=150	Price index for exports of goods (excluding uranium, aircraft and parts, and motor vehicles and parts) to the United States
PXNW13	11766	7.12	X=151	Price index for exports of goods (excluding wheat, uranium, and aircraft and parts) to other countries
PXS	13845		E=83	Price index for exports of services
PXW13	12407		E=53	Price index for exports of wheat to other countries
PYFA	13520		E=86	Price deflator for accrued farm income
Q1	11073		E=145	First-quarter seasonal dummy
Q2	11074		E=146	Second-quarter seasonal dummy
Q3	11075		E=147	Third-quarter seasonal dummy

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
Q4	11076		E=148	Fourth-quarter seasonal dummy
QAUTO	11723		E=260	Variable to reflect increased rationalization of production under the terms of the Canadian-U.S. auto pact. Zero prior to 1Q63 then rises (changing in 4Q of each year) to 3.56 in 4Q68
QAUTST	11745		E=121	Variable to reflect U.S. auto strikes. Equals -1.0 in 4Q64 and 4Q67, +1.0 in 1Q65, .5 in 3Q67 and 1Q68, zero elsewhere
QBROKE	13904		E=191	Variable to reflect reaction to the bankruptcy of Atlantic Acceptance Corporation. Equals 1.0 from 1Q65 to 4Q65, zero elsewhere
QC1	11982		E=192	First-quarter constrained dummy variable, equals Q1 minus Q4
QC2	11983		E=193	Second-quarter constrained dummy variable, equals Q2 minus Q4
QC3	11984		E=194	Third-quarter constrained dummy variable, equals Q3 minus Q4
QCRISIS	14678		E=196	Variable to capture effects of exchange crises on short rates. Equals 1.0 in 3Q62, 1Q68 and 2Q68, zero elsewhere
QDB	BS220		E=195	Bank deposit variable. Equals 1.0 from 1Q62 forward, zero elsewhere
QDBA	14680		E=315	Variable to reflect introduction of Bank

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				Act changes in 3Q67 removing interest rate ceilings on bank loans. Equals 1.0 from 3Q67 on, zero elsewhere
QDBAD	14609		E=77	Variable in wage equation. Equals 1.0 from 1Q52 to 1Q61, zero elsewhere
QDCARS	13673		E=288	Variable to account for the effect of the Canadian-U.S. auto pact on customs duties. Equals 1.0 from 1Q65 forward, zero elsewhere
QDCENT	13679		E=319	Variable to account for irregular observations in provincial-municipal nonwage current expenditure. Equals 1.0 from 3Q66 to 2Q67, zero elsewhere
QDGOOD	14610		E=76	Variable in wage equation. Equals 1.0 from 2Q61 forward, zero elsewhere
QDKEN	13675		E=292	Variable to capture effects of Kennedy Round trade concessions on customs duties. Equals 1.0 from 1Q68 to 2Q69, 2.5 from 3Q69 forward, zero elsewhere
QDNINS	13908		E=181	Variable to reflect amendment of the

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				Unemployment Insurance Act increasing its coverage. Equals 1.0 from 2Q67 forward, zero elsewhere
QDNUSA	11758		E=280	Variable to reflect increased duty-free allowances for tourists to countries other than the United States. Equals 1.0 from 4Q58 to 2Q62, zero elsewhere
QDSEAS	13678		E=318	Variable to account for change in quarterly pattern in provincial-municipal nonwage current expenditure. Equals 1.0 from 1Q65 forward, zero elsewhere
QDTCCF1	13651		E=241	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q52 to 4Q63, zero elsewhere
QDTCCF2	13652		E=242	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q64 to 4Q64, zero elsewhere
QDTCCF3	13653		E=243	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q65 to 4Q65, zero elsewhere
QDTCCF4	13654		E=244	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q66 to 4Q67, zero elsewhere
QDTCCF5	13655		E=245	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q68 to 4Q68, zero elsewhere

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
QDTCCF6	13656		E=246	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q69 to 4Q69, zero elsewhere
QDTCCF7	13657		E=247	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q70 to 4Q70, zero elsewhere
QDTCCF8	13658		E=248	Variable to reflect changing corporation tax practices. Equals 1.0 from 1Q71 forward, zero elsewhere
QDTCCF9	13659		E=249	Variable to reflect changing corporation tax practices. Equals 1.0 in 3Q68 and 1Q69, -1.0 in 2Q68 and 4Q68, zero elsewhere
QDTIEXF	13900		E=166	Variable to reflect the period when motor vehicles were exigible. Equals 1.0 from 1Q55 to 2Q61, zero elsewhere
QDUIF	13907		E=180	Variable to reflect structural changes in the operation of the Unemployment Insurance Fund. Equals 1.0 from 3Q68 forward, zero elsewhere
QDUSA	11759		E=1	Variable to reflect decreased duty-free allowances for tourists to the United States. Equals 1.0 from 3Q62 forward, zero elsewhere
QDXINC	13676		E=293	Variable to capture effects of duty re-mission programme (1964) on customs

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				duties. Equals 1.0 from 1Q64 to 4Q64, zero elsewhere
QEUROPM	14604		E=205	Variable to account for European borrowing by provincial and municipal governments in mid-1968. Equals .33 in 2Q68, 1.0 in 3Q68, zero elsewhere
QEXPO	11780		E=3	Variable to reflect effects of Expo67. Equals 1.0 from 2Q67 to 4Q67, zero elsewhere
QFLEX	13902		E=188	Variable to span period of flexible exchange rates, stopping when government announced intention of achieving higher PFX. Equals 1.0 from 1Q52 to 2Q61, zero elsewhere
QLOBO	13903		E=185	Variable to reflect exchange rate uncertainty and federal government policy announcements discouraging foreign borrowing. Equals 1.0 from 3Q60 to 3Q62, zero elsewhere
QMEF12	14623		E=284	Variable to reflect change in seasonal pattern of oil imports due to increased relative importance of refining capacity in the Maritimes. Equals 1.0 in 1Q of each year from 1964 on, zero elsewhere
QMIDEAST	14645		E=299	Variable to reflect foreign purchases of Canadian oil shares in response to closing of Suez Canal. Equals 1.0 from 3Q67 to 4Q67, zero elsewhere
QNHA	14671		E=321	Variable to represent the period of National

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				Housing Act rate ceilings. Equals 1.0 from 1Q54 to 3Q67, zero elsewhere
QOIL	14651		E=289	Variable to account for large capital inflow from Royal Dutch Shell to finance purchase of Canadian Oil Companies by Shell Investments. Equals 1.0 in 4Q62, zero elsewhere
QSALE	14611		E=178	Variable to reflect an identified sale of a large U.S. subsidiary by a Canadian corporation. Equals 1.0 in 3Q66, zero elsewhere
QSEA	11779		E=91	Variable to reflect completion of St. Lawrence seaway. Equals 1.0 from 3Q59 forward, zero elsewhere
QSTRIKE	14685		E=212	Variable to represent strikes anticipated in steel, nickel and copper. Equals 20.0 in 4Q67, 60.0 in 1Q68, 55.0 in 2Q68, 10.0 in 3Q68, -20.0 in 4Q68, zero elsewhere
QTHERM	11724		E=50	Variable to reflect completion of gas pipelines and increased thermal capacity in Ontario. Equals 1.0 from 1Q65 forward, zero elsewhere
QTIME	14612		E=6	Time trend. Equals 1.0 in 1Q50, 2.0 in 2Q50, etc.
QTSTEP	13648		E=59	Step time trend. Equals 1.0 in each quarter of 1950, 2.0 in each quarter of 1951, etc.
QUSTAX	14644		E=298	Variable to represent portfolio changes in response to announce-

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				ment of U.S. tax proposals unfavourable to U.S. mutual funds holding Canadian securities. Equals .33 from 3Q61 to 3Q62, .89 in 4Q62, 2.3 from 1Q63 to 4Q65, zero elsewhere
QXDIV	14662		E=309	Variable to account for identified dividend receipt of $60 million from a U.K. subsidiary in 4Q62. Equals 1.0 in 4Q62, zero elsewhere
RABEL	BS625	16.11	X=152	Earning liquid asset ratio of chartered banks
RABELD	BS626		E=184	Earning liquid asset ratio of chartered banks, trend-through-troughs using Lagrangian polynomial
RBCR	BS630	16.4	X=17	Required cash reserve ratio of chartered banks
RCB2	FM91		E=190	U.S. corporate bond rate
RCD2	FM109		E=219	U.S. certificate of deposit rate
RCME	14616	3.9	X=53	Imputed rental price for machinery and equipment (per cent per quarter)
RCNR	14617	3.10	X=54	Imputed rental price for non-residential construction (per cent per quarter)
RDC	11006		E=123	Rate of dividend tax credit
RDP2	FM126		E=304	U.S. dividend/price ratio
REUR	11391		E=202	90-day Euro-dollar rate
RFAQ	13602		E=124	Rate of federal personal

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				income tax abatement to Quebec
RFAXQ	13601		E=125	Weighted average rate of federal personal income tax abatement to all provinces except Quebec
RHO	11817	18.6	X=154	Approximation to the nominal supply price of capital
RHO2	14613		E=52	Approximation to the U.S. nominal supply price of capital

RHO2 = RHOR2 + JW [J4P (PXB2)]

t		JW [J4P (PXB2)]
w	=	0 before 1Q65
0		.286
-1		.238
-2		.190
-3		.143
-4		.095
-5		.048
Sum w		1.000

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
RHOR	13800	18.5	X=155	Approximation to the real supply price of capital
RHOR2	14614		E=233	Approximation to the U.S. real supply price of capital

$$RHOR2 = .5\ (RCB2 - JW\ [J4P\ (PXB2)]) + .5\ \frac{[J4A\ (YPCT\$2)]\ [RDP2]}{YDV\$2}$$

t		JW [J4P (PXB2)]
w	=	0 before 1Q65
0		.286
-1		.238
-2		.190
-3		.143
-4		.095
-5		.048
Sum w		1.000

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
RL	13518	17.2	X=156	Average yield on Government of Canada bonds, 10 years and over

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
RLUK	14605		E=206	U.K. interest rate on long-term securities
RMC	1096(8)	17.8	X=153	Conventional mortgage rate
RML	13517	17.3	X=246	Average yield on Government of Canada bonds, 5-10 years
RMS	13516	17.4	X=247	Average yield on Government of Canada bonds, 3-5 years
RNHA	BS245		E=154	Interest rate ceiling on NHA mortgages
RNPT	BS205(8)	17.5	X=158	Rate on nonpersonal term and notice deposits in chartered banks
RNU	14691	5.13	X=192	The unemployment rate
RPD	14664		E=314	Average rate on personal deposits in chartered banks
RS	13515	17.1	X=159	Average yield on Government of Canada bonds, 1-3 years
RSTL	BS202		E=323	Rate on trust and loan company chequable accounts
RSWP	BS204(8)	17.6	X=160	Rate on swapped deposits in chartered banks
RTB2	FM87		E=54	U.S. treasury bill rate
RTCA	11987		E=174	Weighted marginal rate of corporation income tax
RTCAF	13546		E=175	Weighted marginal rate of federal corporation income tax
RTISFME	11620		E=165	Rate of manufacturers sales tax applicable to production machinery and equipment
RTISFR	11621		E=164	Rate of manufacturers sales tax applicable

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				to construction materials and building supplies
RTISFS	11025		E=163	Basic rate of manufacturers sales tax applicable to expenditure on consumer durables and non-durables, and non-production machinery and equipment
RTISPM	11996		E=168	Weighted average rate of provincial retail sales tax
RTPYF1C	11019		E=126	Weighted average rate of federal income tax payable by taxpayers with assessed incomes between $0 and $3,000
RTPYF2C	11020		E=127	Weighted average rate of federal income tax payable by taxpayers with assessed incomes between $3,000 and $5,000
RTPYF3C	11021		E=128	Weighted average rate of federal income tax payable by taxpayers with assessed incomes between $5,000 and $10,000
RTPYF4C	11022		E=129	Weighted average rate of federal income tax payable by taxpayers with assessed incomes exceeding $10,000
RTPYFB1C	13595		E=130	Weighted average rate of basic tax payable by taxpayers with assessed incomes between $0 and $3,000
RTPYFB2C	13596		E=131	Weighted average rate of basic tax payable by taxpayers with assessed incomes between $3,000 and $5,000
RTPYFB3C	13597		E=132	Weighted average rate of basic tax payable by

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				taxpayers with assessed incomes between $5,000 and $10,000
RTPYFB4C	13598		E=133	Weighted average rate of basic tax payable by taxpayers with assessed incomes exceeding $10,000
RTPYPQ	13600		E=134	Weighted average rate of provincial income tax payable by Quebec residents
RTPYPXQ	13599		E=135	Weighted average rate of provincial income tax payable by residents of all provinces except Quebec
RTTL	BS209	17.7	X=264	Rate on one-year deposits in trust companies
RVB12	3761	20.9	X=161	Return to U.S. residents from Canadian business assets (percentage of total return)
RVB13	3762	20.10	X=162	Return to residents of other countries from Canadian business assets (percentage of total return)
SA$2	FM160		E=300	U.S. personal savings plus corporate retained earnings net of taxes
SHM	14649	2.5	X=163	Stock of multiple dwellings (thousand units)
SHS	14648	2.4	X=139	Stock of single-detached dwellings (thousand units)
TANW	13551	9.6	X=164	Personal income tax accruals on nonwage income
TAW	13550	9.5	X=165	Personal income tax

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				accruals on wage income
TCA	D40064	9.33	X=166	Corporation income tax accruals
TCAF	D40065	9.35	X=167	Federal corporation income tax accruals
TCAGBE	11964		E=238	Corporation income taxes on government business enterprises
TCAPLMT	11626		E=176	Provincial mining and logging taxes
TCAPM	D40067	9.36	X=168	Provincial corporation income tax accruals
TCCF	D40066	14.1	X=169	Federal corporation income tax collections
TCPPF	D40062		E=216	Contributions to Canada Pension Plan
TICUSF	2157	10.2	X=170	Customs duties
TIEXF	11969	10.3	X=171	Excise taxes and duties (excluding manufacturers sales tax)
TIGASPM	11971	10.5	X=172	Gasoline tax
TILGS	D40009	10.8	X=49	Indirect taxes less subsidies
TIMVPM	11972	10.6	X=173	Motor vehicle licences and permits, business
TIOF	11979		E=55	Other federal indirect taxes
TIOPM	11994		E=56	Other provincial-municipal indirect taxes
TISF	11270	10.1	X=174	Manufacturers sales tax
TISPM	11970	10.4	X=175	Retail sales tax
TOPF	11978		E=57	Other federal personal direct taxes
TOPPM	11993		E=58	Other provincial-municipal personal

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				direct taxes
TPO	11024	9.2	X=178	Personal income tax collections not withheld at source
TPS	11023	9.1	X=179	Personal income tax collections withheld at source
TPYF	11976	9.4	X=180	Federal personal income tax collections
TPYPM	11977	9.3	X=181	Provincial personal income tax collections
TQPPPM	D40063		E=222	Contributions to Quebec Pension Plan
TRFPR	D40075		E=214	Transfers from persons to federal government
TRHPMPR	11975	9.30	X=258	Hospital and medical care insurance premiums
TRHPR	D40078		E=215	Transfers from persons to hospitals
TRMVPMPR	11973	9.31	X=177	Motor vehicle licences and permits, persons
TROPMPR	13641		E=213	Other transfers from persons to provincial and municipal governments
TRSIGPR	13647		E=232	Employer and employee contributions to social insurance and government pension plans (excluding unemployment insurance contributions and payments to Canada Pension Plan and Quebec Pension Plan)
TUIRF	D1236(7)	11.1	X=228	Unemployment Insurance Fund revenue
TWF	D40069	10.7	X=182	Non-resident withholding tax
UBAL	11900	21.7	X=184	Net balance of payments

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				with all countries on current and long-term capital account (million Canadian dollars)
UBAL12	11899	21.6	X=183	Net balance of payments with the United States on current and long-term capital account (million Canadian dollars)
UGNWNH	14635	14.13	X=98	Government nonwage expenditure (excluding current expenditure by hospitals) (1961 dollars)
UGPP	13820	3.13	X=189	Gross private business product (excluding agriculture and non-commercial services) (1961 dollars)
UGPPA	13854	3.14	X=187	UGPP adjusted to remove unintended inventory changes
UGPPAMP	14618	3.11	X=23	Preferred output according to vintage stock of machinery and equipment
UGPPANP	14619	3.12	X=50	Preferred output according to vintage stock of non-residential construction
UGPPD	13849	3.15	X=190	Desired output based on production function with actual capital stock, average employment rate and trended weekly hours
UGPPS	13853	3.16	X=186	Aggregate supply based on production function with actual factor inputs
UKRMVNC	13544	9.32	X=245	Stock of noncommerical registered motor vehicles (million vehicles)
ULS	13713	21.9	X=85	Net international short-term liabilities

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				outstanding between Canada and the rest of the world (+ if net liability is of Canada to the rest of the world) (million U.S. dollars)
URES	11806(9)	21.8	X=188	Canadian foreign exchange reserves, including gold, U.S. dollars, other convertible currencies and reserve position in the IMF (million U.S. dollars)
V	11815	18.4	X=197	Market value of private sector wealth
VCN$2	FM138		E=186	Net worth of U.S. households at beginning of quarter (trillion dollars)
VKB	11800	18.1	X=191	Market value of the end-of-quarter stock of total business fixed capital and inventories in Canada
VLGB11	13512	18.3	X=196	Market value of resident-held Government of Canada, provincial and municipal bonds
WQC	14640	6.2	X=198	Quarterly wage rate in construction
WQF	13724		E=81	Quarterly wage rate in farming
WQGPAF	11926	12.2	X=200	Quarterly wage rate in federal public administration and defence
WQGPAPM	11963	13.2	X=202	Quarterly wage rate in provincial-municipal public administration
WQIOS	13725		E=60	Quarterly wage rate in noncommercial

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				institutions (excluding schools)
WQISM	11929	See p. v	X=203	Quarterly wage rate in elementary and secondary schools
WQMMOB	13852	6.1	X=199	Quarterly wage rate in mining, manufacturing and other business
X	D40233	4.28	X=204	Exports of goods and services
X$12	13728	4.24	X=205	Exports of goods and services to the United States (current dollars)
X$13	13729	4.26	X=206	Exports of goods and services to other countries (current dollars)
XB2	FM3		E=264	U.S. gross private domestic business product (1958 dollars)
XBAL$	14692	4.31	X=193	Net balance on current account, balance of payments basis (current dollars)
XBC2	FM26		E=265	Production capacity of U.S. producers durables
XBCF2	FM297		E=287	Percentage deviation of European industrial production from trend
XFS$12	D51512	4.12	X=207	Freight and shipping receipts from the United States
XFS$13	13801	4.15	X=208	Freight and shipping receipts from other countries
XG	D40234	4.29	X=97	Exports of goods
XID$12	D51508	4.10	X=209	Interest and dividend receipts from the United States

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
XID$13	13802	4.13	X=210	Interest and dividend receipts from other countries
XIH$	D50515		E=44	Exports. Inheritances and immigrants' funds from all countries
XMIS12	13838		E=78	Exports of uranium, and aircraft and parts to the United States plus miscellaneous adjusting entries
XMIS13	13839		E=61	Exports of uranium, and aircraft and parts to other countries plus miscellaneous adjusting entries
XMV12	11771	4.7	X=211	Exports of motor vehicles and parts to the United States
XNMV12	11769	4.8	X=212	Exports of goods (excluding uranium, aircraft and parts, and motor vehicles and parts) to the United States
XNW13	11761	4.9	X=213	Exports of goods (excluding wheat, uranium, and aircraft and parts) to other countries
XOBE$2	FM48		E=266	U.S. gross national product
XOS$12	14628		E=156	Exports of other services to the United States
XOS$13	14629		E=158	Exports of other services to other countries
XTR$12	D51506	4.11	X=216	Travel receipts from the United States
XTR$13	13806	4.14	X=217	Travel receipts from other countries
XTRP$	D40041		E=38	Transfer payments to Canadian residents from persons abroad
XVOL$	14622		E=270	World trade (excluding

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				U.S. and Canadian imports) (million U.S. dollars)
XW13	11763		E=62	Exports of wheat to other countries
YC	D40002	8.1	X=218	Corporate profits before tax
YCGBE	14687		E=322	Gross profits of government business enterprises
YCR	D40176	8.10	X=219	Retained corporate profits
YCR$2	FM41		E=302	U.S. retained corporate profits
YCT	11647	9.34	X=220	Taxable corporate profits
YDIV11	2406	8.2	X=221	Dividends paid to Canadian residents by Canadian corporations
YDIVF	14638	8.3	X=222	Dividends (before withholding tax) paid to foreign shareholders by Canadian corporations
YDP	D40057	8.9	X=8	Disposable personal income
YDV$2	FM62		E=231	U.S. corporate dividends
YDW	11747	8.6	X=223	Disposable wage income
YF	D40034		E=63	Farm cash income
YFA	D40005		E=64	Accrued farm income
YGIF	13536		E=65	Federal investment income
YGIH	D40083		E=229	Hospital investment income
YGIPM	11992		E=223	Provincial-municipal investment income
YGNE	D40012	8.4	X=226	Gross national expenditure
YGPP	11688	8.5	X=227	Gross private business

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				product
YII$2	FM167		E=230	U.S. interest income
YIVA	D40007		E=239	Inventory valuation adjustment
YKGP	14690	8.12	X=80	Capital gains, realized and accrued, on equities and bonds
YMISC	13819		E=69	Miscellaneous personal nonwage income
YMISCP	14633		E=209	Miscellaneous personal investment income
YNFNC	D40006	See p. v	X=229	Net income of non-farm unincorporated business, including rent
YNWAS	13560	9.9	X=230	Assessed nonwage income
YNWAS1C	13561	9.18	X=231	Assessed nonwage income, income class 1
YNWAS2C	13562	9.19	X=232	Assessed nonwage income, income class 2
YNWAS3C	13563	9.20	X=233	Assessed nonwage income, income class 3
YNWAS4C	13564	9.21	X=234	Assessed nonwage income, income class 4
YP	D40042	8.8	X=7	Personal income
YPCC$2	FM61		E=136	Cash flow of U.S. corporations after taxes
YPCCB	D40037		E=71	Charitable contributions by corporations
YPCT$2	FM60		E=305	U.S. net corporate profits after taxes
YPDNWP	14689	8.11	X=79	Permanent disposable nonwage personal income
YRES	11528	8.7	X=241	Simulation residual defined as zero throughout sample period

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
YTOTPM	13677	13.7	X=248	Total provincial-municipal revenue (national accounts basis)
YW	D40000	6.3	X=235	Wage bill
YWAS	13555	9.8	X=236	Assessed wage income
YWAS1C	13556	9.14	X=237	Assessed wage income, income class 1
YWAS2C	13557	9.15	X=238	Assessed wage income, income class 2
YWAS3C	13558	9.16	X=239	Assessed wage income, income class 3
YWAS4C	13559	9.17	X=240	Assessed wage income, income class 4
YWSLP	11825		E=150	Supplementary labour income, private sector
YWX	13726		E=72	Wage bill residual
ZDEPREC	14643		E=301	Variable used to capture realignment of foreign direct investment in Canada due to depreciation incentives given in the June 1963 budget to firms with a minimum of 25% Canadian ownership. Equals 1.0 from 2Q63 to 4Q65, zero elsewhere
ZEUROF	14603		E=204	Variable to account for federal borrowing of Deutsche Marks in 2Q68. Equals 175.0 in 2Q68, zero elsewhere
ZEXYNW1C	13583		E=137	Average exemption and deduction for taxpayer earning non-wage income, income class 1 (dollars)
ZEXYNW2C	13584		E=138	Average exemption and deduction for taxpayer earning non-

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				wage income, income class 2 (dollars)
ZEXYNW3C	13585		E=139	Average exemption and deduction for taxpayer earning non-wage income, income class 3 (dollars)
ZEXYNW4C	13586		E=140	Average exemption and deduction for taxpayer earning non-wage income, income class 4 (dollars)
ZEXYW1C	13579		E=141	Average exemption and deduction for taxpayer earning wage income, income class 1 (dollars)
ZEXYW2C	13580		E=142	Average exemption and deduction for taxpayer earning wage income, income class 2 (dollars)
ZEXYW3C	13581		E=143	Average exemption and deduction for taxpayer earning wage income, income class 3 (dollars)
ZEXYW4C	13582		E=144	Average exemption and deduction for taxpayer earning wage income, income class 4 (dollars)
ZFXOF	13701		E=74	Official excess demand for 90-day forward exchange (million U.S. dollars)
ZRBSR	BS629		E=161	Required secondary reserve ratio of chartered banks
ZRESD	13705		E=73	Desired or target level of foreign exchange reserves (million U.S. dollars)
ZTR	13711		E=75	Trading strategy variable, +1.0 when PFX moves up through par,

Mnemonic	RDX2 Tape No.	Eq. No. For Endogenous Variables	Simulator Coding No.	Title
				-1.0 when PFX moves down through par
ZWW	11320		E=197	Winter works variable. Equals 1.0 from 3Q63 to 2Q66, zero elsewhere

APPENDIX B

STRUCTURAL EQUATIONS OF RDX2

This appendix is in two parts: first, a summary table containing the titles of Sectors 1 to 21 of the model and the number of behavioural and technical equations in each sector, and second, the 258 equations comprising RDX2 grouped by sector (and sub-sector in the case of Sector 9). The equations are arranged in numerical order within each sector.

Two sectors consist entirely of behavioural equations. The other sectors contain both stochastic behavioural equations and non-stochastic technical relationships, with the behavioural equations appearing first. In order to reduce the number of technical relationships, we have substituted out most of the less complicated ones. In some cases, this makes the behavioural equations somewhat more difficult to read, but decreases the number of variables to be kept in mind.

Each equation is headed by its mnemonic and a description of the equation. In the case of stochastic equations, a record of the method and period of estimation appears immediately under the description. Most of these equations are estimated by ordinary least squares (OLS), but when an equation has a high first-order autocorrelation of residuals it has been re-estimated

by the Hildreth-Lu procedure [1] to check for parameter stability under first-order transformation. In some cases the Hildreth-Lu result is reported instead of that obtained from the original OLS specification. Thus the estimation method is shown as OLS-HL, and the chosen coefficient of first-order autocorrelation (car) is recorded in the line of statistics below the equation. The statistics reported at the end of every behavioural equation always include the standard error of the estimate (see), the coefficient of determination corrected for degrees of freedom (RB2), the Durbin-Watson statistic (dw), and sometimes the coefficient of variation (cov) measured as a percentage. The absolute value of the t-statistic is shown in brackets under the coefficient. (There is a problem in the interpretation of the RB2 statistic for regressions without a constant term. The sum of the explained variance, about the mean, and the residual variance may be greater than the total variance of the dependent variable. Two definitions of a 'pseudo' R2 suggest themselves for use in these circumstances: one equal to the explained variance over the total variance and the other equal to 1.0 minus the ratio of the residual variance to the total variance. We have calculated both measures for our regressions without constant terms, and have found them in all cases to be the same to at least four decimal places.)

[1] Hildreth, Clifford and John Y. Lu: "Demand Relations with Autocorrelated Disturbances." East Lansing, Michigan, Michigan State University, 1960. 76 p. (Michigan Agricultural Experiment Station Technical Bulletin 276.)

We make full use in the equations of the 'J operators' explained in Appendix A. The JW operator is used for distributed lags. The weights for each JW series are reported below the equation in which the operator is used. If the weights are specified a priori, the estimated coefficient on the weighted variable and the associated t-statistic are reported in the equation. If the JW weights are estimated subject to the constraint that they lie on a polynomial of specified order, each weight shown below the equation has a bracketed t-statistic on its right. In the estimation of these constrained lag distributions we have used a modified version of the Almon technique.

The Almon variables used in a regression are indicated by a list of numbered Zs shown under the column of t-statistics of the estimated weights. From this list one can obtain all the necessary information about the degree of the polynomial and any constraint that may have been placed on it. The modified Almon technique we employ allows us to change the degree of the polynomial or to impose other more specific constraints simply by using or not using certain of the Almon variables in the reqression.

The degree of the polynomial is indicated by the last Z of those reported. For example, if a fourth degree polynomial is used a Z4 appears as the last Z in the list; similarly for a second degree polynomial the last Z reported would be Z2. Dropping the first Almon variable, Z0, from the regression list constrains the polynomial to pass through zero at some specified end point in the distribution. (This constraint is automatically imposed in our programme, hence Z0 will never appear in any

of our Z lists.) If Z1 is dropped a further constraint is imposed - the polynomial has a zero slope as well as a zero value at the end point of the distribution. Hence, an Almon list such as Z2 Z3 Z4 appearing with the estimated lag weights indicates that the weights have been constrained to lie on a fourth degree polynomial that passes through zero and, as well, has a zero slope in the quarter immediately prior to the earliest nonzero value shown in the related table of weights.

If the polynomial is constrained to pass through zero at t+1, the quarter following the current quarter, a C is appended to the Zs. In that case, the degree of the polynomial is still determined by the last Almon variable used and the zero end point constraint is still obtained (automatically) by not using ZC0. However, ZC1 must be dropped from the regression for this further constraint, so that to obtain a zero slope constraint at the end point ZC2 must be dropped. Therefore a list such as ZC3 ZC4 indicates that the fourth degree polynomial is constrained to be zero at time t+1 and at the end point of the distribution, as well as to have a zero slope at this end point.

RDX2 EQUATIONS BY SECTOR

Sector	Number of Equations		
	Behavioural	Technical	Total
1. Consumer Expenditure	4	3	7
2. Residential Construction	5		5
3. Business Investment and Output	3	13	16
4. Foreign Trade	22	9	31
5. Business Employment, Hours, Labour Force, and Population	7	6	13
6. Private Sector Wages	2	1	3
7. Prices	20	3	23
8. Income Components	3	9	12
9. Direct Taxes and Other Current Transfers from Persons			
Personal Income Tax	3	26	29
Transfers from Persons to Provincial-Municipal Governments	2	1	3
Corporation Income Tax	3	1	4
10. Indirect Taxes and Other Government Revenue	7	1	8
11. Transfers to Persons	5	1	6
12. Federal Current and Capital Expenditure on Goods and Services	4	1	5

Sector	Number of Equations		
	Behavioural	Technical	Total
13. Provincial-Municipal Current and Capital Expenditure on Goods and Services	6	2	8
14. Government Asset and Liability Changes	5	8	13
15. Demand for Liquid Assets by Nonfinancial Sector	8	3	11
16. Chartered Bank Assets	6	5	11
17. Interest Rates and Mortgage Approvals	10	1	11
18. The Market Value of Real Capital, Wealth, the Supply Price of Capital and the Expected Rate of Inflation	1	6	7
19. Long-Term Capital Flows	13		13
20. International Portfolio Positions		10	10
21. The Foreign Exchange Market and Short-Term Capital Flows	3	6	9
Total Number of Equations	142	116	258

Sector 1. Consumer Expenditure

1.1 CNDSD Consumer expenditure on non-durables and semi-durables

1Q58-4Q68 OLS

$$\frac{CNDSD}{NPOP} = \underset{(5.71)}{54.901} - \underset{(26.35)}{.06509}\ [QC1(J1L[CNDSD/NPOP])]$$

$$- \underset{(14.53)}{.04251}\ [QC2(J1L[CNDSD/NPOP])]$$

$$- \underset{(20.20)}{.05518}\ [QC3(J1L[CNDSD/NPOP])]$$

$$+ JW[YDW/([PCPI][NPOP])]$$

$$+ \underset{(3.20)}{.40477}\ [YPDNWP/([PCPI][NPOP])]$$

$$+ \underset{(1.73)}{.16558}\ (J4A[YDP-YDW]-YPDNWP)/([PCPI][NPOP])$$

$$- \underset{(4.05)}{608.794}\ J4A(.01\ RHOR)$$

t	JW[YDW...]	
0	.13333	(13.27)
-1	.10208	(13.27)
-2	.07500	(13.27)
-3	.05208	(13.27)
-4	.03333	(13.27)
-5	.01875	(13.27)
-6	.00833	(13.27)
-7	.00208	(13.27)
Sum W =	.42498	Z2

see = 2.84 RB2 = .994 cov = 1.01% dw = 2.05

1.2 CS + CSMVOD Consumer expenditure on services, including imputed services from the stock of motor vehicles and other consumer durables

1Q61-4Q68 OLS

$$\frac{CS + CSMVOD + EMEDPAY/PCS}{NPOP} = \underset{(1.76)}{-\ 10.190}$$

- .00426 [QC1(J1L[(CS+CSMVOD+EMEDPAY/PCS)/NPOP])]
  (1.39)

+ .01791 [QC2(J1L[(CS+CSMVOD+EMEDPAY/PCS)/NPOP])]
  (7.00)

- .00919 [QC3(J1L[(CS+CSMVOD+EMEDPAY/PCS)/NPOP])]
  (4.04)

+ JW[YDW/([PCPI][NPOP])] + JW[YKGP/([PCPI][NPOP])]

+ .78252 [YPDNWP/([PCPI][NPOP])]
  (4.79)

+ .35975 (J4A[YDP-YDW]-YPDNWP)/([PCPI][NPOP])
  (2.85)

- 9.3378 (Q2+Q3)(QEXPO)
  (5.45)

t	JW[YDW...]		JW[YKGP...]	
0	.00789	(.19)		
-1	.03708	(1.65)	.00454	(1.35)
-2	.05765	(7.17)	.00529	(1.63)
-3	.06960	(10.18)	.00543	(1.66)
-4	.07293	(5.60)	.00497	(1.60)
-5	.06763	(4.26)	.00392	(1.53)
-6	.05371	(3.66)	.00226	(1.48)
-7	.03117	(3.31)		
Sum W =	.39767	Z1Z2	.02641	Z1Z2

see = 1.77 RB2 = .992 cov = .63% dw = 2.28

1.3 CMV Consumer expenditure on motor vehicles and parts

1Q58-4Q68 OLS

```
CMV  = - 174.024 + .03666 [QC1(J1L[CMV/NPOP])]
NPOP     (3.90)    (1.46)

     + .23577 [QC2(J1L[CMV/NPOP])]
       (9.18)

     - .10876 [QC3(J1L[CMV/NPOP])]
       (7.00)

     + JW[YDW/([PCPI][NPOP])]

     + .32166 [YPDNWP/([PCPI][NPOP])]
       (3.22)

     - 516.23 J4A[(.055+[(1+.01 RHO)**.25]-1)(PCMV)/PCWTD]
       (3.24)

     - .35148 J1L(KMV/NPOP)
       (3.94)
```

where:

$$PCWTD = \frac{(CNDSD)(PCNDSD)+(CS)(PCS)+(CSMVOD)(PCSMVOD)}{(CNDSD+CS+CSMVOD)}$$

t	JW[YDW...]	
0	.21222	(4.33)
-1	.16248	(4.33)
-2	.11937	(4.33)
-3	.08290	(4.33)
-4	.05305	(4.33)
-5	.02984	(4.33)
-6	.01326	(4.33)
-7	.00332	(4.33)
Sum W =	.67644	Z2

see = 2.34 RB2 = .939 cov = 7.04% dw = 1.60

1.4 CDO Consumer expenditure on durables (excluding motor vehicles and parts)

1Q58-4Q68 OLS

$$\frac{CDO}{NPOP} = \underset{(3.54)}{25.726} - \underset{(17.87)}{.12255}\ [QC1(J1L[CDO/NPOP])]$$

$$- \underset{(4.07)}{.02847}\ [QC2(J1L[CDO/NPOP])]$$

$$+ \underset{(6.19)}{.03700}\ [QC3(J1L[CDO/NPOP])]$$

$$+ JW[YDW/([PCPI][NPOP])] + JW[YKGP/([PCPI][NPOP])]$$

$$- \underset{(4.02)}{465.69}\ J4A[(.055+[(1+.01\ RHO)**.25]-1)(PCDO)/PCWTD]$$

$$+ \underset{(2.65)}{.17220}\ [YPDNWP/([PCPI][NPOP])]$$

$$+ \underset{(3.83)}{.16951}\ (J4A[YDP-YDW]-YPDNWP)/([PCPI][NPOP])$$

$$- \underset{(1.34)}{.02907}\ J1L(KDO/NPOP)$$

where:

$$PCWTD = \frac{(CNDSD)(PCNDSD)+(CS)(PCS)+(CSMVOD)(PCSMVOD)}{(CNDSD+CS+CSMVOD)}$$

t	JW[YDW...]		JW[YKGP...]	
0	.03388	(3.43)		
-1	.02594	(3.43)	.00153	(1.30)
-2	.01906	(3.43)	.00268	(2.45)
-3	.01324	(3.43)	.00327	(3.04)
-4	.00847	(3.43)	.00330	(3.28)
-5	.00476	(3.43)	.00276	(3.36)
-6	.00212	(3.43)	.00166	(3.40)
-7	.00053	(3.43)		
Sum W =	.10800	Z2	.01521	Z1Z2

see = .848 RB2 = .984 cov = 1.99% dw = 1.68

Technical Relationships

1.5 KMV Stock of consumer motor vehicles

KMV = (1-.055)[J1L(KMV)] + (1-.0273)CMV

1.6 KDO Stock of consumer durables (excluding motor vehicles)

KDO = (1-.055)[J1L(KDO)] + (1-.055)CDO

1.7 CSMVOD Imputed consumer services from the stock of motor vehicles and other consumer durables

CSMVOD = .06656 [J1L(KDO+KMV)] + .055 CDO + .0273 CMV

Sector 2. Residential Construction

2.1 IRC Business investment in residential construction

1Q56-4Q68 OLS

$$IRC = -\underset{(.55)}{7.4549}\,QC1 - \underset{(4.79)}{44.121}\,QC2 + \underset{(3.12)}{26.259}\,QC3 + JW(HSTS) + JW(HSTM)$$

t	JW(HSTS)		JW(HSTM)	
0	6.65611	(12.94)	3.50695	(4.75)
-1	4.73186	(10.87)	1.59990	(2.63)
-2	2.73423	(10.19)	2.11137	(4.03)
-3	1.03351	(2.43)	3.22567	(8.96)
-4			3.12711	(5.38)
Sum W =	15.15571	Z1Z2Z3	13.57100	Z1Z2Z3

see = 17.91 RB2 = .964 cov = 3.47% dw = 1.42

2.2 HSTS Housing starts, single-detached (thousand units)

2Q57-4Q68 OLS

$$1000\ HSTS/NHH = \underset{(6.86)}{83.407} - \underset{(11.79)}{2.4719}\,QC1 + \underset{(6.41)}{1.2582}\,QC2$$

$$+ \underset{(5.31)}{1.0529}\,QC3 - \underset{(6.01)}{95.482}\,[J1L(SHS)]/NHH - \underset{(7.29)}{1.2619}\,RMC$$

$$+ \underset{(1.77)}{2.0945}\,J2L[(RABEL-RABELD)/RABEL] - \underset{(.37)}{.09578}\,ZWW$$

$$+ \underset{(2.21)}{.86996}\,(ZWW)(QC1) - \underset{(4.12)}{1.6063}\,(ZWW)(QC2)$$

$$- \underset{(1.60)}{.62465}\,(ZWW)(QC3)$$

see = .673 RB2 = .865 cov = 14.33% dw = 2.25

2.3 HSTM Housing starts, multiples (thousand units)

2Q57-4Q68 OLS

$$1000\ HSTM/NHH = \underset{(3.49)}{8.7130} - \underset{(6.82)}{1.2501}\ QC1 + \underset{(5.97)}{1.1246}\ QC2$$

$$+ \underset{(.23)}{.04710}\ QC3 - \underset{(2.70)}{63.126}\ [J1L(SHM)]/NHH$$

$$+ \underset{(2.34)}{2.3143}\ J2L[(RABEL-RABELD)/RABEL]$$

$$+ \underset{(2.02)}{72.274}\ HAPCMHCM/[(PIRC)(NHH)]$$

$$+ [JW(YDP/PGPP)]/NHH + \underset{(4.01)}{.00247}\ J4D(ATL)$$

$$- \underset{(2.37)}{1.1122}\ QNHA + \underset{(1.25)}{.37245}\ ZWW - \underset{(2.12)}{.71245}\ (ZWW)(QC1)$$

$$- \underset{(.97)}{.31682}\ (ZWW)(QC2) + \underset{(2.35)}{.77793}\ (ZWW)(QC3)$$

t		[JW(YDP...)]/NHH	
0		2.59602	(2.56)
-1		2.27152	(2.56)
-2		1.94702	(2.56)
-3		1.62251	(2.56)
-4		1.29801	(2.56)
-5		.97351	(2.56)
-6		.64901	(2.56)
-7		.32450	(2.56)
Sum W	=	11.68210	Z1

see = .558 RB2 = .878 cov = 13.97% dw = 2.01

2.4 SHS Stock of single-detached dwellings (thousand units)

2Q57-4Q68 OLS

$$J1D(SHS) = \underset{(1.32)}{13.792} - \underset{(3.86)}{4.9500}\ QC1 + \underset{(1.82)}{2.1268}\ QC2 + \underset{(1.77)}{1.5805}\ QC3$$

$$+ JW(HSTS) - \underset{(2.06)}{.00480}\ J1L(SHS)$$

t		JW(HSTS)	
0		.08633	(.86)
-1		.35954	(4.77)
-2		.29942	(4.80)
-3		.11118	(1.48)
Sum W	=	.85647	Z1Z2Z3

see = 2.45 RB2 = .671 dw = 1.32

2.5 SHM Stock of multiple dwellings (thousand units)

2Q57-4Q68 OLS

$$J1D(SHM) = \underset{(5.13)}{8.2781} - \underset{(2.44)}{4.7958}\ QC1 - \underset{(.09)}{.13015}\ QC2 + \underset{(1.72)}{2.1061}\ QC3$$

$$+ JW(HSTM)$$

t		JW(HSTM)	
0		-.30148	(2.19)
-1		.29370	(2.77)
-2		.39136	(4.14)
-3		.22157	(3.34)
-4		.01442	(.14)
Sum W	=	.61957	Z1Z2Z3

see = 3.34 RB2 = .549 dw = 2.29

Sector 3. Business Investment and Output

3.1 IME Business investment in machinery and equipment

1Q59-4Q68 OLS

$$\begin{aligned}
IME-.05\ J1L(KME) = &- \underset{(4.66)}{1422.4}\ Q1 - \underset{(4.20)}{1344.1}\ Q2 - \underset{(4.45)}{1478.4}\ Q3 \\
&- \underset{(4.66)}{1537.8}\ Q4 + \underset{(7.06)}{.08745}\ (Q1[JW(KMEY[JW(UGPPA)-UGPPAMP])]) \\
&+ \underset{(7.62)}{.09684}\ (Q2[JW(KMEY[JW(UGPPA)-UGPPAMP])]) \\
&+ \underset{(5.86)}{.07071}\ (Q3[JW(KMEY[JW(UGPPA)-UGPPAMP])]) \\
&+ \underset{(8.52)}{.10298}\ (Q4[JW(KMEY[JW(UGPPA)-UGPPAMP])]) \\
&+ JW[((FIDI12+FIDI13)/PIME)/J12A((FIDI12+FIDI13)/PIME)] \\
&+ JW[((YCR+CCAC\$)/PIME)/J8A((YCR+CCAC\$)/PIME)] \\
&+ JW[(J1D(ABLB)/PIME)/J8A(J1D(ABLB)/PIME)]
\end{aligned}$$

t	JW(KMEY...)	JW(UGPPA)	JW[((FIDI12...)]	
0			56.028	(4.42)
-1	.1	.912748	56.006	(6.89)
-2	.15	.387471	53.989	(6.38)
-3	.30	.201812	49.977	(7.19)
-4	.25	.023799	43.971	(5.73)
-5	.15	- .007194	35.970	(4.74)
-6	.05	- .038344	25.975	(4.09)
-7		- .056743	13.985	(3.64)
-8		- .065876		
-9		- .069366		
-10		- .069598		
-11		- .068029		
-12		- .065530		
Sum W =	1.00	1.085150	335.899	Z1Z2

t	JW[((YCR...)]		JW[(J1D(ABLB)...)]	
0	396.334	(3.56)	2.46848	(1.65)
-1	275.232	(3.56)	1.57983	(1.65)
-2	176.148	(3.56)	.88865	(1.65)
-3	99.084	(3.56)	.39496	(1.65)
-4	44.037	(3.56)	.09874	(1.65)
-5	11.009	(3.56)		
Sum W =	1001.844	Z2	5.43066	Z2

see = 44.69   RB2 = .933   dw = 1.94

3.2 INRC Business investment in non-residential construction

1Q59-4Q68 OLS

INRC-.01 J1L(KNRC) = - 167.08 Q1 - 72.736 Q2 + 74.429 Q3
(.40) (.17) (.17)

- 14.450 Q4 + .04625 (Q1[JW(KNRY[JW(UGPPA)-UGPPANP])])
(.03) (10.94)

+ .05372 (Q2[JW(KNRY[JW(UGPPA)-UGPPANP])])
(12.11)

+ .06262 (Q3[JW(KNRY[JW(UGPPA)-UGPPANP])])
(13.80)

+ .05845 (Q4[JW(KNRY[JW(UGPPA)-UGPPANP])])
(12.03)

+ JW[((FIDI12+FIDI13)/PINRC)/J8A((FIDI12+FIDI13)/PINRC)]

+ JW[((YCR+CCAC$)/PINRC)/J8A((YCR+CCAC$)/PINRC)]

+ JW[RL/J8A(RL)]

t	JW(KNRY...)	JW(UGPPA)	JW[((FIDI12...)]	
0			- 4.3967	(.62)
-1		1.013285	6.1418	(1.15)
-2	.06	.408832	14.6525	(2.84)
-3	.11	.191007	21.1355	(3.61)
-4	.16	.063129	25.5907	(3.84)
-5	.17	- .010338	28.0181	(3.89)
-6	.16	- .051142	28.4178	(3.89)
-7	.13	- .072476	26.7898	(3.87)
-8	.11	- .082322	23.1340	(3.85)
-9	.07	- .089550	17.4504	(3.82)
-10	.04	- .084890	9.7391	(3.80)
-11		- .082237		
-12		- .073857		
Sum W =	1.01	1.129441	196.6729	Z1Z2

t	JW[((YCR...)]		JW[RL/J8A(RL)]	
0	75.471	(1.09)	- 54.028	(1.39)
-1	101.010	(1.78)	- 75.948	(2.89)
-2	120.068	(2.58)	- 92.502	(5.40)
-3	132.647	(3.45)	-103.690	(8.08)
-4	138.746	(4.31)	-109.511	(8.04)
-5	138.365	(5.02)	-109.966	(6.80)
-6	131.504	(5.51)	-105.054	(5.82)
-7	118.163	(5.77)	- 94.776	(5.17)
-8	98.342	(5.84)	- 79.132	(4.72)
-9	72.041	(5.81)	- 58.121	(4.39)
-10	39.261	(5.71)	- 31.744	(4.15)
Sum W =	1165.617	Z1Z2	-914.474	Z1Z2

see = 20.76   RB2 = .978   dw = .74

3.3 IIB Change in nonfarm business inventories

1Q56-4Q68 OLS

$$IIB = \underset{(3.03)}{373.96} + \underset{(3.02)}{.00823}\,[QC1(J1L(KIB))]$$

$$+ \underset{(.92)}{.00281}\,[QC2(J1L(KIB))] - \underset{(3.23)}{.00859}\,[QC3(J1L(KIB))]$$

$$- \underset{(2.69)}{.16088}\,J1L(KIB) + \underset{(9.19)}{.46104}\,[UGPPS-(UGPP-IIB)]$$

$$+ JW[CNDSD+CMV+CDO+XG+(GCNWF+GCNWPM+GCGSH$$

$$-CCAGF\$-CCAGPM\$-CCAGH\$)/PGCNWG]$$

$$+ JW(MG) + JW(IME+INRC+IRC+IMEGF+IMEGPM+INRCGF$$

$$+INRCGPM+INRCSM+IH+EIADJ)$$

t	JW[CNDSD...]		JW(MG)	
0	.02842	(.39)	.13186	(1.61)
-1	.03485	(.92)	.04464	(1.02)
-2	.03843	(2.82)	-.02236	(1.03)
-3	.03916	(2.51)	-.06916	(2.65)
-4	.03703	(1.41)	-.09574	(2.65)
-5	.03205	(1.04)	-.10212	(2.56)
-6	.02422	(.87)	-.08829	(2.50)
-7	.01354	(.76)	-.05425	(2.46)
Sum W =	.24769	Z1Z2	-.25542	Z1Z2

t	JW(IME...)	
0	.16217	(2.92)
-1	.08615	(2.73)
-2	.02606	(1.31)
-3	-.01811	(.81)
-4	-.04634	(1.68)
-5	-.05865	(2.02)
-6	-.05503	(2.20)
-7	-.03548	(2.29)
Sum W =	.06077	Z1Z2

see = 66.24 RB2 = .888 dw = 2.37

Technical Relationships

3.4 KME Stock of machinery and equipment

KME = .95 J1L(KME) + IME

3.5 KNRC Stock of non-residential construction

KNRC = .99 J1L(KNRC) + INRC

3.6 KIB Stock of nonfarm business inventories

KIB = J1L(KIB) + IIB

3.7 KMEY Desired capital/output ratio for machinery and equipment

$$KMEY = \frac{1}{2.7985}\ [(.205/.145)^{**}.145][(.205/.65)^{**}.65]$$
$$[(JW[WQMMOB/(13\ HAWMM)][(1-.01\ RTCA)/.01\ RCME])^{**}.65][(RCNR/RCME)^{**}.145]$$

3.8 KNRY Desired capital/output ratio for non-residential construction

$$KNRY = \frac{1}{2.7985}\ [(.145/.205)^{**}.205][(.145/.65)^{**}.65]$$
$$[(JW[WQMMOB/(13\ HAWMM)][(1-.01\ RTCA)/.01\ RCNR])^{**}.65][(RCME/RCNR)^{**}.205]$$

3.9 RCME Imputed rental price for machinery and equipment (per cent per quarter)

$$RCME = JW(PIME)(1-CPVME(\frac{.01\ RTCA}{.50}))(.05 + [(1+.01[RHO2][LDIRV12/KB\$]+.01[RHO][1-LDIRV12/KB\$])^{**}.25-1][1-.01\ RTCA(\frac{J4S(ECINT)}{J4S(ECINT+YC)})])100$$

3.10 RCNR Imputed rental price for non-residential construction (per cent per quarter)

$$RCNR = JW(PINRC)\left(1-CPVNR\left(\frac{.01\ RTCA}{.50}\right)\right)\Big(.01 + \big[(1+.01[RHO2][LDIRV12/KB\$]+.01[RHO][1-LDIRV12/KB\$])^{.25}-1\big]\Big[1-.01\ RTCA\left(\frac{J4S(ECINT)}{J4S(ECINT+YC)}\right)\Big]\Big)100$$

JW weights for equations 3.7 to 3.10

t	JW[WQMMOB/(13 HAWMM)] for KMEY	JW[WQMMOB/(13 HAWMM)] for KNRY	JW(PIME)	JW(PINRC)
-1	.82630	1.66328	.83756	.89508
-2	.29377	.59134	.35618	.37927
-3	.16898	.34015	.18653	.19719
-4	.09411	.18943	.08704	.02162
-5	.04946	.09956	- .03900	- .00787
-6	.02311	.04651	- .03912	- .03804
-7	.00788	.01567	- .05197	- .05585
-8	- .00090	- .00181	- .05975	- .06466
-9	- .00561	- .01130	- .06292	- .06800
-10	- .00797	- .01605	- .06326	- .06819
-11	- .00895	- .01801	- .06200	- .06666
-12	- .09988	- .20106	- .05991	- .06423
Sum W =	1.34030	2.69771	1.02938	1.05966

3.11 UGPPAMP Preferred output according to vintage stock of machinery and equipment

$$UGPPAMP = .95\ J1L(UGPPAMP) + IME/J3L(KMEY)$$

3.12 UGPPANP Preferred output according to vintage stock of non-residential construction

$$UGPPANP = .99\ J1L(UGPPANP) + INRC/J5L(KNRY)$$

3.13 UGPP Gross private business product (excluding agriculture and noncommercial services) (1961 dollars)

$$UGPP = YGPP/PGPP$$

3.14 UGPPA UGPP adjusted to remove unintended inventory changes

$$UGPPA = UGPP - .4610\ [UGPPS-89.9-(UGPP-IIB)]$$

3.15 UGPPD — Desired output based on production function with actual capital stock, average employment rate and trended weekly hours

$$UGPPD = 2.943\ ([J1L(KME)]^{**}.205)([J1L(KNRC)]^{**}.145)\left(\left[\left(\frac{41.246-.009282\ QTIME}{.12685}\right)(NMMOB)\left(1+\frac{NL}{NE}-1.05179\right)(ELEFF)\right]^{**}.65\right)$$

3.16 UGPPS — Aggregate supply based on production function with actual factor inputs

$$UGPPS = 2.943\ ([J1L(KME)]^{**}.205)([J1L(KNRC)]^{**}.145)\left(\left[\left(\frac{HAWMM}{.12685}\right)(NMMOB)(ELEFF)\right]^{**}.65\right)$$

Sector 4. Foreign Trade

4.1 MFB12 Imports of food and beverages from the United States (SITC 0,1)

1Q58-3Q68 OLS

MFB12 = 118.46 − .05834 [QC1(J1L(MFB12))]
(4.68) (3.75)

+ .09647 [QC2(J1L(MFB12))] − .02174 [QC3(J1L(MFB12))]
(5.81) (1.49)

+ .01811 (.834 CNDSD+.0276 UGNWNH+.0164 IIB+.1221 XG)
(11.85)

+ JW(PMFB12/PCPI)

t	JW(PMFB12/PCPI)	
0	-25.43051	(2.69)
-1	-20.48424	(3.70)
-2	-16.04295	(4.15)
-3	-12.10665	(2.79)
-4	- 8.67534	(1.69)
-5	- 5.74902	(1.09)
-6	- 3.32769	(.74)
-7	- 1.41135	(.51)
Sum W =	-93.22776	Z1Z2

see = 4.74 RB2 = .863 cov = 5.79% dw = 1.25

4.2 MEF12 Imports of energy fuels from the United States (SITC 3)

1Q58-3Q68 OLS

```
MEF12 = 11.2656 - .27822 [QC1(J1L(MEF12))]
        (1.22)    (5.42)

    + .26424 [QC2(J1L(MEF12))] + .06955 [QC3(J1L(MEF12))]
      (3.76)                     (2.03)

    + .00454 [.601 CNDSD+.085 (IRC+INRC)+.072 UGNWNH
      (1.27)

             +.014 IIB+.23 XG](PGPP/PMEF12)

    + 13.439 QTHERM - 22.810 QMEF12 + .43207 J1L(MEF12)
      (3.51)          (6.12)          (4.75)
```

see = 5.10   RB2 = .901   cov = 12.05%   dw = 1.32

4.3 MCM12 Imports of crude materials from the United States (SITC 2, 4)

1Q58-3Q68 OLS

```
MCM12 = 2.1683 - .10693 [QC1(J1L(MCM12))]
        (.22)    (4.40)

    + .05038 [QC2(J1L(MCM12))] - .01016 [QC3(J1L(MCM12))]
      (1.82)                     (.42)

    + .00804 [(UGPP)(J4A(UGPPA/UGPPD)/J4A(XB2/XBC2))]
      (9.62)
```

see = 9.00   RB2 = .755   cov = 9.56%   dw = .83

4.4 MMF12 Imports of manufactures (excluding transportation equipment) from the United States (SITC 5-8 [excluding transportation equipment])

1Q58-3Q68 OLS

$$MMF12 = \underset{(6.15)}{156.54} + \underset{(3.99)}{.041559}\ [QC1(J1L(MMF12))]$$

$$+ \underset{(1.78)}{.019727}\ [QC2(J1L(MMF12))] - \underset{(1.18)}{.009650}\ [QC3(J1L(MMF12))]$$

$$+ \underset{(4.56)}{.22112}\ [(.16\ CNDSD+.33\ (CMV+CDO)+.09\ UGNWNH$$

$$+.01\ IIB+.29\ IME+.12\ XG)(PGPP/PMMF12)$$

$$(J4A(UGPPA/UGPPD))]$$

$$+ \underset{(4.85)}{.29119}\ [(IME)(PGPP/PMMF12)(J4A(UGPPA/UGPPD))]$$

see = 22.75 RB2 = .976 cov = 3.19% dw = 1.84

4.5 MMV12 Imports of motor vehicles and parts from the United States

1Q58-3Q68 OLS

$$MMV12 = \underset{(1.58)}{20.270} + \underset{(.90)}{.020440}\ [QC1(J1L(MMV12))]$$

$$- \underset{(6.32)}{.14517}\ [QC2(J1L(MMV12))] - \underset{(4.33)}{.083370}\ [QC3(J1L(MMV12))]$$

$$+ \underset{(8.89)}{.30087}\ CMV + \underset{(29.56)}{.24299}\ (QAUTO)(CMV)$$

$$+ \underset{(3.50)}{.094845}\ (QAUTST)(CMV)$$

see = 19.22 RB2 = .985 cov = 8.83% dw = 2.08

4.6 MNTE13 Imports of goods (excluding transportation equipment and unclassified commodity transactions [SITC 9]) from other countries (SITC 0-8 [excluding transportation equipment])

1Q58-3Q68 OLS

$$MNTE13 = \underset{(8.29)}{84.900} - \underset{(14.55)}{.13305}\,[QC1(J1L(MNTE13))]$$

$$+ \underset{(1.07)}{.01150}\,[QC2(J1L(MNTE13))] + \underset{(8.54)}{.07680}\,[QC3(J1L(MNTE13))]$$

$$+ JW[(PGPP/PMNTE13)(.096\ CNDSD+.3837\ (CMV+CDO)$$

$$+.3617\ IME+.0073\ (IRC+INRC)+.0854\ UGNWNH$$

$$+.1279\ IIB+.0809\ XG)]$$

t	JW[(PGPP...)]	
0	.09949	(40.43)
-1	.07617	(40.43)
-2	.05596	(40.43)
-3	.03886	(40.43)
-4	.02487	(40.43)
-5	.01399	(40.43)
-6	.00622	(40.43)
-7	.00155	(40.43)
Sum W =	.31713	Z2

see = 17.39 RB2 = .980 cov = 3.61% dw = 2.24

4.7 XMV12 Exports of motor vehicles and parts to the United States

1Q63-4Q68 OLS

$$XMV12 = - \underset{(.02)}{.08711} + \underset{(6.45)}{.13874}\,[QC1(J1L(XMV12))]$$

$$+ \underset{(4.44)}{.08737}\,[QC2(J1L(XMV12))] - \underset{(1.32)}{.02402}\,[QC3(J1L(XMV12))]$$

$$+ \underset{(71.59)}{9.2880}\,(QAUTO)[(EC2/ESAEC2)+.001(CDO+CMV)]$$

see = 14.48 RB2 = .996 cov = 6.90% dw = 1.89

4.8 XNMV12 Exports of goods (excluding uranium, aircraft and parts, and motor vehicles and parts) to the United States

1Q57-4Q68 OLS

XNMV12 = - 2649.3 - .09686 (QC1[J4L(XNMV12)])
(14.25) (9.77)

+ .03741 (QC2[J4L(XNMV12)]) + .02307 (QC3[J4L(XNMV12)])
(4.37) (2.70)

+ JW(XB2/XBC2)

+ JW[((XOBE$2/ESAX02)/.01 POBE2)(XB2/XBC2)]

+ JW[(PFX)[(EPS$2+EPD$2)/(EPS2+EPD2)]/J4A(PXNMV12)]

+ .85801 QSTRIKE
(1.96)

t	JW(XB2/XBC2)		JW[((XOBE$2...)]	
0	997.90	(7.51)		
-1	561.32	(7.51)		
-2	249.47	(7.51)		
-3	62.37	(7.51)		
-4				
-5			.05056	(.12)
-6			.42842	(1.63)
-7			.72980	(5.21)
-8			.95468	(14.02)
-9			1.10307	(11.67)
-10			1.17497	(8.18)
-11			1.17037	(6.64)
-12			1.08928	(5.82)
-13			.93170	(5.31)
-14			.69763	(4.97)
-15			.38706	(4.72)
Sum W =	1871.06	Z2	8.71752	Z1Z2

t	JW[(PFX)...]	
-1	351.876	(9.97)
-2	258.521	(9.97)
-3	179.528	(9.97)
-4	114.898	(9.97)
-5	64.630	(9.97)
-6	28.725	(9.97)
-7	7.181	(9.97)
Sum W =	1005.359	Z2

see = 30.48 RB2 = .985 cov = 3.29% dw = 1.86

4.9 XNW13 Exports of goods (excluding wheat, uranium, and aircraft and parts) to other countries

4Q54-4Q68 OLS

$$\ln(XNW13) = -\underset{(5.25)}{4.7181} - \underset{(6.06)}{.01383}\,[QC1(J4L[\ln(XNW13)])]$$

$$+ \underset{(.60)}{.00135}\,[QC2(J4L[\ln(XNW13)])]$$

$$+ \underset{(3.83)}{.00893}\,[QC3(J4L[\ln(XNW13)])]$$

$$+ \underset{(12.34)}{1.0698}\,\ln[XVOL\$/PWXG] + JW[\ln(PXNW13/[(PWXG)(PFX)])]$$

$$+ JW[\ln(J4A(UGPPA/UGPPD))]$$

$$+ \underset{(2.10)}{.00859}\,(QFLEX)(\ln[XVOL\$/PWXG])$$

t		JW[ln(PXNW13...)]		JW[ln(J4A...)]	
0				-.21322	(1.53)
-1		-.41563	(2.28)	-.17769	(1.53)
-2		-.23379	(2.28)	-.14215	(1.53)
-3		-.10391	(2.28)	-.10661	(1.53)
-4		-.02598	(2.28)	-.07107	(1.53)
-5				-.03554	(1.53)
Sum W	=	-.77930	Z2	-.74628	Z1

see = .060 RB2 = .951 cov = .96% dw = 1.64

4.10 XID$12 Interest and dividend receipts from the United States

1Q54-4Q68 OLS

$$\frac{XID\$12}{(YII\$2+YDV\$2)(PFX)} = \underset{(18.11)}{.99732}\ (Q1[1000\ A12/([PFX][1000000\ VCN\$2]+A12)])$$

$$+ \underset{(17.75)}{.98372}\ (Q2[1000\ A12/([PFX][1000000\ VCN\$2]+A12)])$$

$$+ \underset{(17.66)}{.98299}\ (Q3[1000\ A12/([PFX][1000000\ VCN\$2]+A12)])$$

$$+ \underset{(23.68)}{1.3116}\ (Q4[1000\ A12/([PFX][1000000\ VCN\$2]+A12)])$$

see = .244 RB2 = .267 cov = 20.06% dw = 1.09

4.11 XTR$12 Travel receipts from the United States

3Q54-4Q68 OLS

$$(XTR\$12/N2) = - \underset{(4.80)}{1.4040} - \underset{(22.28)}{.99590}\ [QC1(J1L(XTR\$12/N2))]$$

$$- \underset{(4.50)}{.23741}\ [QC2(J1L(XTR\$12/N2))]$$

$$+ \underset{(46.11)}{1.4316}\ [QC3(J1L(XTR\$12/N2))]$$

$$+ JW(PFX) + JW[(ECO\$2/ESAEC2)/N2] + \underset{(7.48)}{.39155}\ QEXPO$$

t	JW(PFX)		JW[(ECO$2...]	
0	.38420	(3.32)	.53405	(7.14)
-1	.29415	(3.32)	.40888	(7.14)
-2	.21611	(3.32)	.30040	(7.14)
-3	.15008	(3.32)	.20861	(7.14)
-4	.09605	(3.32)	.13351	(7.14)
-5	.05403	(3.32)	.07510	(7.14)
-6	.02401	(3.32)	.03338	(7.14)
-7	.00600	(3.32)	.00834	(7.14)
Sum W =	1.22464	Z2	1.70228	Z2

see = .078 RB2 = .985 cov = 11.07% dw = 2.33

4.12 XFS$12 Freight and shipping receipts from the United States

3Q54-4Q68 OLS

$$XFS\$12 = \underset{(1.30)}{5.1619} - \underset{(5.72)}{.076171}\,[QC1(J1L(XFS\$12))]$$

$$- \underset{(.73)}{.010625}\,[QC2(J1L(XFS\$12))]$$

$$+ \underset{(6.57)}{.081555}\,[QC3(J1L(XFS\$12))] + \underset{(11.81)}{.067668}\,XG\$12$$

$$- \underset{(5.67)}{.005076}\,(QAUTO)(XG\$12) - \underset{(1.14)}{.002524}\,(QSEA)(XG\$12)$$

where:

$$XG\$12 = (XMV12)(PXMV12) + (XNMV12)(PXNMV12)$$

$$+ (XMIS12)(PXMIS12)$$

see = 4.00 RB2 = .970 cov = 5.66% dw = 1.40

4.13 XID$13 Interest and dividend receipts from other countries

1Q57-4Q68 OLS

$$XID\$13 = \underset{(20.48)}{.28443}\,(.30420\;J20A[.01\;RLUK]+.03775)(A13)$$

$$- \underset{(3.39)}{.08306}\,[QC1(.30420\;J20A[.01\;RLUK]+.03775)(A13)]$$

$$- \underset{(.07)}{.00158}\,[QC2(.30420\;J20A[.01\;RLUK]+.03775)(A13)]$$

$$- \underset{(3.46)}{.08205}\,[QC3(.30420\;J20A[.01\;RLUK]+.03775)(A13)]$$

$$+ \underset{(6.72)}{54.629}\,QXDIV$$

see = 7.76 RB2 = .759 cov = 31.96% dw = 2.06

4.14 XTR$13 Travel receipts from other countries

3Q54-4Q68 OLS

$$XTR\$13 = -\underset{(4.66)}{7.6749} - \underset{(10.66)}{.80801}\ [QC1(J1L(XTR\$13))]$$

$$+\underset{(4.79)}{.42689}\ [QC2(J1L(XTR\$13))] + \underset{(13.34)}{.61111}\ [QC3(J1L(XTR\$13))]$$

$$+ JW(.001\ XVOL\$) + \underset{(7.58)}{18.010}\ QEXPO$$

t	JW(.001 XVOL$)	
0	.26792	(13.49)
-1	.20513	(13.49)
-2	.15071	(13.49)
-3	.10466	(13.49)
-4	.06698	(13.49)
-5	.03768	(13.49)
-6	.01675	(13.49)
-7	.00419	(13.49)
Sum W =	.85400	Z2

see = 3.55 RB2 = .929 cov = 23.01% dw = 1.95

4.15 XFS\$13 Freight and shipping receipts from other countries

3Q54-4Q68 OLS

$$\underset{}{XFS\$13} = \underset{(.94)}{3.5009} - \underset{(.97)}{.026559}\,[QC1(J1L(XFS\$13))]$$

$$+ \underset{(.58)}{.017269}\,[QC2(J1L(XFS\$13))]$$

$$- \underset{(.01)}{.000219}\,[QC3(J1L(XFS\$13))] + \underset{(5.51)}{.073912}\,XG\$13$$

$$+ \underset{(2.37)}{.026906}\,J1L(XG\$13) - \underset{(2.58)}{.011889}\,(QSEA)(XG\$13)$$

where:

$$XG\$13 = (XNW13)(PXNW13) + (XW13)(PXW13) + (XMIS13)(PXMIS13)$$

see = 5.47 RB2 = .929 cov = 7.98% dw = .70

4.16 MINT\$12 Interest payments to the United States

1Q57-4Q68 OLS

$$MINT\$12 = \underset{(102.2)}{.25899}\,\left[\left(.757\left(\frac{J20S[(FI12)(.01\ RCB2/PFX)]}{J20S(FI12)}\right)(PFX)\right.\right.$$

$$\left.+ .243\left(\frac{J20S[(FI12)(.01\ RL)]}{J20S(FI12)}\right)\right)(LGB12+LCB12)]$$

$$- \underset{(6.29)}{.028607}\,(QC1[\text{same as first term}])$$

$$+ \underset{(8.20)}{.036267}\,(QC2[\text{same as first term}])$$

$$- \underset{(8.18)}{.035531}\,(QC3[\text{same as first term}])$$

where:

$$FI12 = FINIGF12 + FINIPM12 + FINIB12 + FITOGB12 + FITOBB12$$

see = 5.12 RB2 = .972 cov = 7.25% dw = 1.14

4.17 MDIV$12 Dividend payments to the United States

1Q57-4Q68 OLS

$$
\begin{aligned}
\text{MDIV\$12} = {} & \underset{(5.49)}{.03784}\ \text{J4S}[([\text{LDIRV12}+\text{LPCV12}]/\text{KB\$})(\text{YC}+\text{CCAC\$}-\text{TCA})] \\
& - \underset{(2.29)}{.00434}\ [\text{QC1}(\text{J4S}[([\text{LDIRV12}+\text{LPCV12}]/\text{KB\$})(\text{YC}+\text{CCAC\$}-\text{TCA})])] \\
& - \underset{(2.91)}{.00620}\ [\text{QC2}(\text{J4S}[([\text{LDIRV12}+\text{LPCV12}]/\text{KB\$})(\text{YC}+\text{CCAC\$}-\text{TCA})])] \\
& - \underset{(2.60)}{.00505}\ [\text{QC3}(\text{J4S}[([\text{LDIRV12}+\text{LPCV12}]/\text{KB\$})(\text{YC}+\text{CCAC\$}-\text{TCA})])] \\
& + \underset{(1.68)}{.24324}\ \text{J4L}(\text{MDIV\$12})
\end{aligned}
$$

see = 16.33 RB2 = .853 cov =14.08% dw = 1.99

4.18 MTR$12 Travel payments to the United States

3Q54-4Q68 OLS

$$\frac{MTR\$12}{NPOP} = \underset{(5.25)}{15.554} - \underset{(7.25)}{.18629}\ [QC1(J1L(MTR\$12/NPOP))]$$

$$+ \underset{(5.16)}{.12002}\ [QC2(J1L(MTR\$12/NPOP))]$$

$$+ \underset{(14.94)}{.28421}\ [QC3(J1L(MTR\$12/NPOP))]$$

$$+ \underset{(8.84)}{.037807}\ ([(PCS)(CS)+(PCSMVOD)(CSMVOD)]/NPOP)$$

$$- \underset{(2.67)}{.98817}\ (QDUSA+QDNUSA) + JW(PFX)$$

t		JW(PFX)	
0		- 6.82427	(4.26)
-1		- 4.36753	(4.26)
-2		- 2.45674	(4.26)
-3		- 1.09188	(4.26)
-4		- .27297	(4.26)
Sum W	=	-15.01340	Z2

see = .86 RB2 = .896 cov = 8.87% dw = 1.82

4.19 MFS$12 Freight and shipping payments to the United States

3Q54-4Q68 OLS

$$MFS\$12 = \underset{(2.77)}{42.551} - \underset{(18.98)}{.18657}\,[QC1(J1L(MFS\$12))]$$

$$+ \underset{(.36)}{.00630}\,[QC2(J1L(MFS\$12))]$$

$$+ \underset{(6.80)}{.12602}\,[QC3(J1L(MFS\$12))]$$

$$+ \underset{(6.55)}{.05979}\,MG\$12 + \underset{(1.18)}{.00976}\,J1L(MG\$12)$$

$$- \underset{(5.73)}{.004315}\,(QAUTO)(MG\$12) + JW(PFX)$$

where:

$$MG\$12 = (MFB12)(PMFB12) + (MEF12)(PMEF12)$$

$$+ (MCM12)(PMCM12) + (MMF12)(PMMF12)$$

$$+ (MMV12)(PMMV12) + (MMIS12)(PMMIS12)$$

t		JW(PFX)	
0		-12.05357	(1.45)
-1		- 7.71429	(1.45)
-2		- 4.33929	(1.45)
-3		- 1.92857	(1.45)
-4		- .48214	(1.45)
Sum W	=	-26.51786	Z2

see = 3.84 RB2 = .979 cov = 3.97% dw = 1.40

4.20 MID$13 Interest and dividend payments to other countries

1Q57-4Q68 OLS

$$MID\$13 = \underset{(45.80)}{.19237} [.241\ J20A(.01\ RL)+.013](LDIPRV13+LGB13)$$

$$+ \underset{(4.08)}{.03026} [QC1[.241\ J20A(.01\ RL)+.013](LDIPRV13+LGB13)]$$

$$- \underset{(4.67)}{.03414} [QC2[.241\ J20A(.01\ RL)+.013](LDIPRV13+LGB13)]$$

$$- \underset{(1.43)}{.01037} [QC3[.241\ J20A(.01\ RL)+.013](LDIPRV13+LGB13)]$$

see = 5.38 RB2 = .596 cov = 15.27% dw = 1.28

4.21 MTR$13 Travel payments to other countries

3Q54-4Q68 OLS

$$\frac{MTR\$13}{NPOP} = - \underset{(2.65)}{3.3876} - \underset{(12.14)}{.33879} [QC1(J1L(MTR\$13/NPOP))]$$

$$- \underset{(3.05)}{.08700} [QC2(J1L(MTR\$13/NPOP))]$$

$$+ \underset{(24.06)}{.57639} [QC3(J1L(MTR\$13/NPOP))]$$

$$+ \underset{(8.37)}{.016086} ([(PCS)(CS)+(PCSMVOD)(CSMVOD)]/NPOP)$$

$$- \underset{(2.24)}{.53982} QEXPO + \underset{(2.62)}{.42244} (QDUSA+QDNUSA) + JW(PFX)$$

t	JW(PFX)	
0	1.09531	(1.59)
-1	.70100	(1.59)
-2	.39431	(1.59)
-3	.17525	(1.59)
-4	.04381	(1.59)
Sum W =	2.40968	Z2

see = .370 RB2 = .949 cov = 10.03% dw = 1.86

4.22 MFS$13 Freight and shipping payments to other countries

3Q54-4Q68 OLS

$$MFS\$13 = -\underset{(2.66)}{39.037} + \underset{(3.57)}{.05990}\,[QC1(J1L(MFS\$13))]$$

$$-\underset{(2.60)}{.03911}\,[QC2(J1L(MFS\$13))] - \underset{(.66)}{.00907}\,[QC3(J1L(MFS\$13))]$$

$$+\underset{(15.13)}{.08596}\,MG\$13 + \underset{(6.04)}{9.0420}\,QSEA + JW(PFX)$$

where:

$$MG\$13 = (MNTE13)(PMNTE13) + (MMV13)(PMMV13) + (MMIS13)(PMMIS13)$$

t	JW(PFX)	
0	20.72174	(2.80)
-1	13.26191	(2.80)
-2	7.45982	(2.80)
-3	3.31548	(2.80)
-4	.82887	(2.80)
Sum W =	45.58782	Z2

see = 3.64   RB2 = .964   cov = 6.23%   dw = .97

Technical Relationships

4.23 M$12 Imports of goods and services from the United States (current dollars)

$$M\$12 = (MFB12)(PMFB12) + (MEF12)(PMEF12) + (MCM12)(PMCM12) + (MMF12)(PMMF12) + (MMV12)(PMMV12) + (MMIS12)(PMMIS12) + MINT\$12 + MDIV\$12 + MTR\$12 + MFS\$12 + MOS\$12$$

4.24 X\$12 Exports of goods and services to the United States (current dollars)

$$X\$12 = (XMV12)(PXMV12) + (XNMV12)(PXNMV12) + (XMIS12)(PXMIS12) + XID\$12 + XTR\$12 + XFS\$12 + XOS\$12$$

4.25 M\$13 Imports of goods and services from other countries (current dollars)

$$M\$13 = (MNTE13)(PMNTE13) + (MMV13)(PMMV13) + (MMIS13)(PMMIS13) + MID\$13 + MTR\$13 + MFS\$13 + MOS\$13$$

4.26 X\$13 Exports of goods and services to other countries (current dollars)

$$X\$13 = (XNW13)(PXNW13) + (XW13)(PXW13) + (XMIS13)(PXMIS13) + XID\$13 + XTR\$13 + XFS\$13 + XOS\$13$$

4.27 M Imports of goods and services

$$M = MG + (MINT\$12+MDIV\$12+MTR\$12+MFS\$12+MOS\$12+MID\$13+MTR\$13+MFS\$13+MOS\$13+TWF-MTRP\$-GTNRF-MIH\$)/PMS$$

4.28 X Exports of goods and services

$$X = XG + (XID\$12+XTR\$12+XFS\$12+XOS\$12+XID\$13+XTR\$13+XFS\$13+XOS\$13-XTRP\$-XIH\$)/PXS$$

4.29 XG Exports of goods

XG = XMV12 + XNMV12 + XW13 + XNW13 + XMIS12 +XMIS13

4.30 MG Imports of goods

MG = MFB12 + MEF12 + MCM12 + MMF12 + MMV12 + MMIS12
+ MNTE13 + MMV13 + MMIS13

4.31 XBAL$ Net balance on current account, balance of payments basis (current dollars)

XBAL$ = X$12 + X$13 - M$12 - M$13

Sector 5. Business Employment, Hours, Labour Force and Population

5.1 NMMOB Paid employees in mining, manufacturing and other business

1Q61-4Q68 OLS

$$JID(NMMOB) = \underset{(1.56)}{.01171} - \underset{(8.30)}{.02809}\,[QC1(J1L(NMMOB))]$$

$$+ \underset{(9.33)}{.02771}\,[QC2(J1L(NMMOB))] + \underset{(12.56)}{.02629}\,[QC3(J1L(NMMOB))]$$

$$+ \underset{(4.18)}{.12174}\,[NMMOBD-J1L(NMMOB)]$$

see = .026 RB2 = .959 dw = 1.94

5.2 NC Paid employees in construction

1Q55-4Q68 OLS

$$NC = \underset{(5.58)}{.10163} - \underset{(12.11)}{.04335}\,QC1 + \underset{(8.30)}{.04209}\,QC2 + \underset{(12.66)}{.03421}\,QC3$$

$$+ \underset{(4.09)}{.00005327}\,J12A(INRC+IRC)$$

$$+ \underset{(1.98)}{.00002920}\,[INRC+IRC-J12A(INRC+IRC)]$$

$$- \underset{(4.48)}{.50393}\,(.01\,RNU) + \underset{(6.71)}{.56689}\,J1L(NC)$$

see = .007 RB2 = .983 cov = 2.08% dw = 1.61

5.3 HAWMM Average weekly hours worked in mining and manufacturing

1Q61-4Q68 OLS

$$\frac{HAWMM - (41.246 - .009282\ QTIME)}{(41.246 - .009282\ QTIME)} = \underset{(1.76)}{-\ .00237} + \underset{(3.16)}{.00668}\ QC1$$

$$+ \underset{(.27)}{.00048}\ QC2 + \underset{(3.99)}{.00664}\ QC3 + \underset{(5.21)}{.12906} \left(\frac{NMMOBD - NMMOB}{NMMOBD}\right)$$

see = .005 RB2 = .660 dw = 1.49

5.4 HAWC Average weekly hours worked in construction

1Q55-4Q68 OLS

$$HAWC = \underset{(485.38)}{40.8320} - \underset{(.31)}{.05056}\ QC1 + \underset{(1.92)}{.24363}\ QC2 + \underset{(10.02)}{1.6572}\ QC3$$

$$+ \underset{(5.63)}{.004969} [INRC - J12A(INRC)]$$

see = .538 RB2 = .889 cov = 1.31% dw = 1.44

5.5 NL Labour force

2Q57-4Q68 OLS

$$100\ J1D(NL/NPOP) = \underset{(3.00)}{.13462} - \underset{(9.18)}{.76533}\ QC1 + \underset{(5.29)}{.53182}\ QC2$$

$$+ \underset{(12.89)}{1.0125}\ QC3 - \underset{(5.49)}{.53264}\ (Q1+Q2)(100\ J1D[NPOPSS/NPOP])$$

$$- \underset{(7.36)}{.89777}\ (Q3+Q4)(100\ J1D[NPOPSS/NPOP])$$

$$+ \underset{(2.43)}{.01688}\ J1D[J4A(YDP/([PCPI][NPOP]))]$$

$$+ \underset{(2.32)}{29.599}\ J1D[J19S(NIMS-NEMS)/NPOP]$$

see = .187 RB2 = .982 dw = 1.79

5.6 NIMS Immigrants

1Q59-4Q68 OLS

```
100(NIMS/NPOP) = .73253 - .09575 QC1 + .03315 QC2
                 (1.45)   (10.63)      (3.34)

    + .05988 QC3 + JW[RNU]
      (6.32)

    + JW[(J1L[.5071 WQMMOB/([13 HAWMM][PCPI])])/

       (.86 EWEURO+.14[.3956 PL2/PCON2])] + JW(NPOP)
```

t	JW[RNU]		JW[(J1L[...]	
0			.13429	(1.14)
-1			.10281	(1.14)
-2	-.01924	(5.35)	.07554	(1.14)
-3	-.01674	(6.73)	.05246	(1.14)
-4	-.01437	(8.67)	.03357	(1.14)
-5	-.01212	(10.21)	.01888	(1.14)
-6	-.01001	(9.04)	.00839	(1.14)
-7	-.00802	(6.62)	.00210	(1.14)
-8	-.00616	(4.80)		
-9	-.00443	(3.62)		
-10	-.00282	(2.83)		
-11	-.00135	(2.27)		
Sum W =	-.09524	Z1Z2	.42804	Z2

t	JW(NPOP)	
0	-.00687	(2.06)
-1	-.00601	(2.06)
-2	-.00515	(2.06)
-3	-.00429	(2.06)
-4	-.00343	(2.06)
-5	-.00258	(2.06)
-6	-.00172	(2.06)
-7	-.00086	(2.06)
Sum W =	-.03091	Z1

see = .031   RB2 = .910   cov = 12.3%   dw = 1.56

5.7 NEMS Emigrants

1Q55-4Q68 OLS

$$100(NEMS/NPOP) = \underset{(4.90)}{.09023} - \underset{(4.14)}{.02290}\ QC1 - \underset{(.38)}{.00208}\ QC2$$

$$+ \underset{(3.70)}{.02045}\ QC3 + JW[J4A(1/RNU)]$$

$$+ JW[.01\ J4A([LF2+LA2]/LU2)]$$

t	JW[J4A(1/RNU)]		JW[.01 J4A(...)]	
0	-.11064	(2.09)	.16876	(2.32)
-1	-.07081	(2.09)	.10801	(2.32)
-2	-.03983	(2.09)	.06075	(2.32)
-3	-.01770	(2.09)	.02700	(2.32)
-4	-.00443	(2.09)	.00675	(2.32)
Sum W =	-.24342	Z2	.37127	Z2

see = .024 RB2 = .321 cov = 20.6% dw = 1.40

Technical Relationships

5.8 NPOPT Total population (beginning-of-quarter figure)

$$J1D(NPOPT) = J1L(NIMS-NEMS+NBIRTHS-NDEATHS)$$

5.9 NPOP Noninstitutional population 14 years of age and over

$$NPOP = (EPOP)(NPOPT)$$

5.10 NE Total employed persons (excluding armed forces)

$$NE = NMMOB + NC + NIS + NGPAF + NGPAPM + NIOS + NFP$$
$$+ NEUPB + NEUPF + NX$$

5.11 NU Total unemployed persons

NU = NL - NE

5.12 NMMOBD Desired level of employment in mining, manufacturing and other business

NMMOBD = [.13182/([41.246-.009282 QTIME][ELEFF])]
[(UGPPA)/[2.943([J1L(KME)]**.205)([J1L(KNRC)]
.145)](1/.65)]

5.13 RNU The unemployment rate

RNU = 100 (NU/NL)

Sector 6. Private Sector Wages

6.1 WQMMOB Quarterly wage rate in mining, manufacturing and other business

1Q55-4Q68 OLS

$$
\begin{aligned}
J1P(WQMMOB) = {} & \underset{(1.76)}{5.9728}\ QDBAD + \underset{(1.43)}{5.1819}\ QDGOOD \\
& + \underset{(.61)}{.12633}\ [QC1(QDBAD)] + \underset{(4.12)}{.74454}\ [QC2(QDBAD)] \\
& + \underset{(4.40)}{.83983}\ [QC3(QDBAD)] + \underset{(4.79)}{.82893}\ [QC1(QDGOOD)] \\
& - \underset{(2.69)}{.46692}\ [QC2(QDGOOD)] - \underset{(6.15)}{1.0152}\ [QC3(QDGOOD)] \\
& + \underset{(3.78)}{29.078}\ ELEFF - \underset{(3.41)}{33.416}\ J1L(.001\ WQMMOB/PCPI) \\
& - \underset{(2.51)}{.23865}\ J4L[J1P(WQMMOB)] + \underset{(1.53)}{.33347}\ PCPICE \\
& + JW[.001((NL/NU)^{**}2)]
\end{aligned}
$$

t	JW[.001((NL/NU)**2)]	
0	.11960	(1.77)
-1	.10465	(1.77)
-2	.08970	(1.77)
-3	.07475	(1.77)
-4	.05980	(1.77)
-5	.04485	(1.77)
-6	.02990	(1.77)
-7	.01495	(1.77)
Sum W =	.53819	Z1

see = .486 RB2 = .787 dw = 2.12

6.2 WQC Quarterly wage rate in construction

1Q55-4Q68 OLS

$$J1P(WQC) = -\underset{(2.87)}{1.5379} + \underset{(9.83)}{3.2094}\ QC1 - \underset{(7.75)}{1.9675}\ QC2 - \underset{(5.85)}{2.7278}\ QC3$$

$$+ \underset{(2.85)}{.41143}\ PCPICE + \underset{(5.30)}{.10630}\ (100/RNU) + \underset{(14.08)}{1.0872}\ J1P(HAWC)$$

see = .905 RB2 = .974 dw = 1.90

Technical Relationship

6.3 YW Wage bill

$$YW = (NMMOB)(WQMMOB) + (NC)(WQC) + (NFP)(WQF)$$
$$+ (NIOS)(WQIOS) + (NIS)(WQISM) + (NGPAF)(WQGPAF)$$
$$+ (NGPAPM)(WQGPAPM) + YWSLP + GWSF + GWPASPM + GWSSM$$
$$+ YWX$$

Sector 7. Prices

7.1 PCNDSD Price of consumer non-durables and semi-durables

1Q58-4Q68 OLS

$$\frac{PCNDSD}{(1+.01\ RTISPM)} = \underset{(1.76)}{.12945}$$

$$- \underset{(4.34)}{.00750}\ [QC1(J1L[PCNDSD/(1+.01\ RTISPM)])]$$

$$+ \underset{(1.42)}{.00207}\ [QC2(J1L[PCNDSD/(1+.01\ RTISPM)])]$$

$$+ \underset{(4.07)}{.00664}\ [QC3(J1L[PCNDSD/(1+.01\ RTISPM)])]$$

$$+ JW[([WQC][NC]+[WQMMOB][NMMOB])/UGPPS]$$

$$+ JW(.3527\ PMFB12+.0719\ PMCM+.1606\ PMEF$$

$$+.4033\ PMMF+.0115\ PMMV)$$

$$+ JW([.01\ RTISPM][J1L(PCNDSD/(1+.01\ RTISPM))])$$

where:

$$PMCM = \left(\frac{(MCM12)(PMCM12) + .1049\ (MNTE13)(PMCM13)}{MCM12 + .1049\ MNTE13}\right)$$

$$PMEF = \left(\frac{(MEF12)(PMEF12) + .1918\ (MNTE13)(PMEF13)}{MEF12 + .1918\ MNTE13}\right)$$

$$PMMF = \left(\frac{(MMF12)(PMMF12) + .5328\ (MNTE13)(PMMF13)}{MMF12 + .5328\ MNTE13}\right)$$

$$PMMV = \left(\frac{(MMV12)(PMMV12) + (MMV13)(PMMV13)}{MMV12 + MMV13}\right)$$

t	JW[([WQC...]		JW(.3527 PMFB12...)	
0	.09233	(.86)	.01150	(.31)
-1	.18448	(3.41)	.02399	(1.45)
-2	.24700	(14.61)	.02909	(1.70)
-3	.27989	(11.19)	.02679	(1.32)
-4	.28316	(6.72)	.01709	(1.13)
-5	.25681	(5.25)		
-6	.20083	(4.54)		
-7	.11523	(4.12)		
Sum W =	1.65974	Z1Z2	.10847	Z1Z2

t	JW([.01 RTISPM...])	
0	-.75102	(3.98)
-1	-.18955	(2.85)
-2	.16628	(1.80)
-3	.31648	(2.70)
-4	.26105	(2.97)
Sum W =	-.19676	Z1Z2

see = .0054 RB2 = .987 cov = .53% dw = 1.25

7.2 PCS Price of consumer services

1Q55-4Q68 OLS

$$\frac{PCS}{(1+.01\ RTISPM)} = \underset{(40.32)}{.41427}$$

$$- \underset{(2.33)}{.00277}\ [QC1(J1L[PCS/(1+.01\ RTISPM)])]$$

$$+ \underset{(1.03)}{.00121}\ [QC2(J1L[PCS/(1+.01\ RTISPM)])]$$

$$+ \underset{(.57)}{.00067}\ [QC3(J1L[PCS/(1+.01\ RTISPM)])]$$

$$+ \underset{(43.39)}{.05551}\ (.01\ WQMMOB)$$

$$- \underset{(5.62)}{.75700}\ [.01\ RTISPM][J1L(PCS/(1+.01\ RTISPM))]$$

see = .0050 RB2 = .997 cov = .51% dw = 1.56

7.3 PCMV Price of consumer motor vehicles

1Q56-4Q68 OLS

$$\frac{PCMV}{(1+.01\ RTISPM)} = -\underset{(6.39)}{3.7841}$$

$$+ \underset{(2.41)}{.01230}\ [QC1(J1L[PCMV/(1+.01\ RTISPM)])]$$

$$- \underset{(.12)}{.00056}\ [QC2(J1L[PCMV/(1+.01\ RTISPM)])]$$

$$- \underset{(4.88)}{.02468}\ [QC3(J1L[PCMV/(1+.01\ RTISPM)])]$$

$$+ JW[(WQMMOB)(NMMOB)/UGPPS] + JW[(PFX)(.01\ PC2)]$$

$$- \underset{(9.02)}{.01724}\ QTIME - \underset{(6.03)}{.08139}\ QAUTO$$

$$+ \underset{(3.00)}{.88582}\ J4A(NMMOB/[(NMMOBD)(41.246-.009282\ QTIME)/HAWMM])$$

t	JW[(WQMMOB)...]		JW[(PFX)(.01 PC2)]	
0	.58234	(1.35)	-.56148	(3.03)
-1	.74934	(2.41)	.05774	(.97)
-2	.87716	(4.16)	.42350	(5.07)
-3	.96579	(7.17)	.53579	(4.86)
-4	1.01523	(10.73)	.39463	(4.72)
-5	1.02548	(10.57)		
-6	.99655	(8.52)		
-7	.92842	(7.00)		
-8	.82111	(6.01)		
-9	.67462	(5.36)		
-10	.48893	(4.90)		
-11	.26406	(4.55)		
Sum W =	9.38903	Z1Z2	.85017	Z1Z2

see = .019 RB2 = .834 cov = 2.01% dw = 1.22

7.4 PCDO Price of other consumer durables

1Q56-4Q68 OLS

```
   PCDO            = - .56698
(1+.01 RTISPM)       (3.68)

    - .00025 [QC1(J1L[PCDO/(1+.01 RTISPM)])]
      (.14)

    + .00347 [QC2(J1L[PCDO/(1+.01 RTISPM)])]
      (1.95)

    - .00222 [QC3(J1L[PCDO/(1+.01 RTISPM)])]
      (1.31)

    - .00474 QTIME + JW[(WQMMOB)(NMMOB)/UGPPS]
      (8,54)

    + JW([.01 RTISPM][J1L(PCDO/(1+.01 RTISPM))])

    + JW[(PFX)(.01 PC2)]

    + .19658 J4A(NMMOB/[(NMMOBD)(41.246-.009282 QTIME)/
      (2.94)

                HAWMM])
```

t	JW[(WQMMOB)...]		JW([.01 RTISPM...])	
0	.50186	(2.00)	-.31374	(2.02)
-1	.72978	(9.77)	-.20080	(2.02)
-2	.79356	(8.55)	-.11295	(2.02)
-3	.69319	(5.25)	-.05020	(2.02)
-4	.42867	(4.18)	-.01255	(2.02)
Sum W =	3.14705	Z1Z2	-.69023	Z2

t	JW[(PFX)(.01 PC2)]	
0	.12868	(3.58)
-1	.08235	(3.58)
-2	.04632	(3.58)
-3	.02059	(3.58)
-4	.00515	(3.58)
Sum W =	.28309	Z2

see = .007 RB2 = .947 cov = .71% dw = .73

7.5 PIME Price deflator for business investment in machinery and equipment

1Q54-4Q68 OLS

$$\frac{PIME}{(1+.0012\ RTISFS+.0088\ RTISFME)} = -\underset{(2.89)}{.20514}$$

$$+ JW[(WQMMOB)(NMMOB)/UGPPS] + JW[(PFX)(.01\ PPD2)]$$

$$+ JW(.01\ PPD2) + JW[J4A(UGPPA/UGPPD)]$$

$$+ JW([.0012\ RTISFS+.0088\ RTISFME][J1L(PIME/(1+.0012\ RTISFS+.0088\ RTISFME))])$$

t	JW[(WQMMOB)...]		JW[(PFX)(.01 PPD2)]	
0	.22898	(4.36)	.29535	(6.78)
-1	.14655	(4.36)	.12922	(14.11)
-2	.08243	(4.36)	.01662	(.91)
-3	.03664	(4.36)	-.04245	(1.62)
-4	.00916	(4.36)	-.04799	(2.38)
Sum W =	.50375	Z2	.35075	Z1Z2

t	JW(.01 PPD2)		JW[J4A(UGPPA...)]	
0	-.03339	(.37)	.11217	(3.68)
-1	.06901	(3.29)	.07179	(3.68)
-2	.12355	(5.01)	.04038	(3.68)
-3	.13023	(3.11)	.01795	(3.68)
-4	.08904	(2.64)	.00449	(3.68)
Sum W =	.37843	Z1Z2	.24678	Z2

t	JW([.0012 RTISFS...])	
0	-.37241	(9.93)
-1	-.14382	(11.93)
-2	.00772	(.61)
-3	.08221	(4.53)
-4	.07963	(5.59)
Sum W =	-.34667	Z1Z2

see = .0053 RB2 = .996 cov = .54% dw = 1.03

7.6 PIRC — Price deflator for private investment in residential construction

1Q54-4Q68 OLS

$$PIRC = \underset{(1.90)}{.08101} + JW(.001\ WQC) + JW(PRM)$$

t	JW(.001 WQC)		JW(PRM)	
0	.10349	(7.38)	.06363	(.92)
-1	.04599	(7.38)	.15985	(9.10)
-2	.01150	(7.38)	.20159	(6.81)
-3			.18887	(4.59)
-4			.12167	(3.85)
Sum W =	.16098	Z2	.73560	Z1Z2

see = .0102 RB2 = .992 cov = .98% dw = .82

7.7 PINRC — Price deflator for business investment in non-residential construction

1Q54-4Q68 OLS

$$PINRC = \underset{(1.74)}{.20781} + \underset{(1.78)}{.08498}\ (.001\ WQC) + JW(PNRM)$$

$$+ \underset{(.20)}{.00049}\ [QC1(.001\ WQC)] + \underset{(.39)}{.00093}\ [QC2(.001\ WQC)]$$

$$- \underset{(2.10)}{.00619}\ [QC3(.001\ WQC)]$$

t	JW(PNRM)	
0	.60485	(5.60)
-1	.26133	(5.94)
-2	.02908	(.54)
-3	-.09189	(1.41)
-4	-.10159	(2.10)
Sum W =	.70177	Z1Z2

see = .0128 RB2 = .977 cov = 1.23% dw = .58

7.8 PKIB Price of the nonfarm business inventory stock

1Q54-4Q68 OLS

$$PKIB = \underset{(2.70)}{.15664} + \underset{(16.47)}{.65086}\ PCPI - \underset{(2.02)}{.00041}\ QTIME$$

$$+ \underset{(7.12)}{.26515}\ J4A(UGPPA/UGPPD)$$

see = .0055 RB2 = .989 cov = .52% dw = .56

7.9 PRM Price index for residential construction materials

1Q56-4Q68 OLS

$$\frac{PRM}{1+\frac{.54\ RTISFR}{100+.54\ RTISFR}} = -\underset{(7.27)}{.79000} + \underset{(2.76)}{.00664}\ \left(QC1\left[J1L\left(\frac{PRM}{1+\frac{.54\ RTISFR}{100+.54\ RTISFR}}\right)\right]\right)$$

$$+ \underset{(1.70)}{.00383}\ \left(QC2\left[J1L\left(\frac{PRM}{1+\frac{.54\ RTISFR}{100+.54\ RTISFR}}\right)\right]\right)$$

$$- \underset{(.90)}{.00209}\ \left(QC3\left[J1L\left(\frac{PRM}{1+\frac{.54\ RTISFR}{100+.54\ RTISFR}}\right)\right]\right)$$

$$+ \underset{(4.37)}{.29744}\ J4A(UGPPA/UGPPD) + JW[(WQMMOB)(NMMOB)/UGPPS]$$

$$+ JW(PXFP)$$

t	JW[(WQMMOB)...]		JW(PXFP)	
0	1.01986	(36.06)	.57862	(6.67)
-1	.65271	(36.06)	.22971	(12.52)
-2	.36715	(36.06)	-.00261	(.07)
-3	.16318	(36.06)	-.11834	(2.19)
-4	.04079	(36.06)	-.11746	(2.83)
Sum W =	2.24369	Z2	.56991	Z1Z2

see = .0099 RB2 = .984 cov = .93% dw = .52

7.10 PNRM Price index for non-residential construction materials

1Q56-4Q68 OLS

$$\frac{PNRM}{\frac{1+.46\ RTISFR}{100+.46\ RTISFR}} = \underset{(1.31)}{.07262}$$

$$+ \underset{(1.62)}{.00220}\ (QC1[J1L(\frac{PNRM}{\frac{1+.46\ RTISFR}{100+.46\ RTISFR}})\ ])$$

$$+ \underset{(1.61)}{.00214}\ (QC2[J1L(\frac{PNRM}{\frac{1+.46\ RTISFR}{100+.46\ RTISFR}})\ ])$$

$$+ \underset{(.01)}{.000019}\ (QC3[J1L(\frac{PNRM}{\frac{1+.46\ RTISFR}{100+.46\ RTISFR}})\ ])$$

$$+ \underset{(4.17)}{.16659}\ J4A(UGPPA/UGPPD) + JW[(WQMMOB)(NMMOB)/UGPPS]$$

$$+ JW([(.01\ RCNR)(PINRC)(KNRC)+(.01\ RCME)(PIME)(KME)]/UGPPS)$$

$$+ JW(PXFP)$$

t	JW[(WQMMOB)...]		JW([(.01 RNCR...)	
0	.61962	(17.41)	.20576	(5.71)
-1	.39655	(17.41)	.13169	(5.71)
-2	.22306	(17.41)	.07407	(5.71)
-3	.09914	(17.41)	.03292	(5.71)
-4	.02478	(17.41)	.00823	(5.71)
Sum W =	1.36315	Z2	.45267	Z2

t	JW(PXFP)	
0	.06137	(3.79)
-1	.03927	(3.79)
-2	.02209	(3.79)
-3	.00982	(3.79)
-4	.00245	(3.79)
Sum W =	.13501	Z2

see = .0057 RB2 = .989 cov = .55% dw = .76

7.11 PXNMV12 — Price index for exports of goods (excluding uranium, aircraft and parts, and motor vehicles and parts) to the United States

1Q53-4Q68 OLS

$$\underset{(3.05)}{\text{PXNMV12} = -\ .19996} + \underset{(2.11)}{.003791\ \text{QC1}} - \underset{(.44)}{.000775\ \text{QC2}}$$

$$- \underset{(2.55)}{.004497\ \text{QC3}} + \underset{(2.73)}{.21392}\ (.58\ \text{PCNDSD}+.09\ \text{PCD0}+.33\ \text{PIME})$$

$$+ \underset{(16.00)}{.63475\ \text{PXFP}} + \underset{(3.17)}{.18865}\ (.01\ \text{PXBNF2})(\text{PFX}) + \text{JW(PFX)}$$

t	JW(PFX)	
0	.03003	(2.53)
-1	.04505	(2.53)
-2	.04505	(2.53)
-3	.03003	(2.53)
Sum W =	.15017	ZC2

see = .008 RB2 = .980 cov = .78% dw = .97

7.12 PXNW13 — Price index for exports of goods (excluding wheat, uranium, and aircraft and parts) to other countries

1Q57-4Q68 OLS

$$\underset{(8.28)}{\text{PXNW13} = -\ .55622} + \underset{(4.45)}{.01707\ \text{QC1}} - \underset{(1.45)}{.00541\ \text{QC2}} - \underset{(2.36)}{.00892\ \text{QC3}}$$

$$+ \underset{(15.37)}{1.2744}\ [.7(.58\ \text{PCNDSD}+.09\ \text{PCD0}+.33\ \text{PIME})+.3(\text{PXFP})]$$

$$+ \underset{(3.12)}{.40165}\ (\text{PFX})(\text{PWXG}) + \text{JW(PFX)}$$

t	JW(PFX)	
0	.30730	(2.03)
-1	-.03968	(.91)
-2	-.20656	(2.59)
-3	-.19333	(2.59)
Sum W =	-.13227	Z1Z2

see = .015 RB2 = .968 cov = 1.41% dw = .84

7.13 PMFB12 Price index for imports of food and beverages from the United States (SITC 0, 1)

1Q58-4Q68 OLS

$$J4P[PMFB12/PFX] = - \underset{(1.12)}{2.0757}$$

$$+ \underset{(1.57)}{1.3865}\ J4P[.8339((EC0\$2-EC\$2)/(EC02-EC2))$$

$$+.0276(.01\ PEGF2)+.0164(.01\ PI2)$$

$$+.1221(.01\ PEEX2)]$$

see = 5.29 RB2 = .033 dw = .89

7.14 PMCM12 Price index for imports of crude materials from the United States (SITC 2, 4)

1Q58-4Q68 OLS

$$J4P[PMCM12/PFX] = - \underset{(3.40)}{2.0416}$$

$$+ \underset{(2.73)}{.90044}\ J4P[.4118((EC0\$2-EC\$2)/(EC02-EC2))$$

$$+.0273(.01\ PEGF2)+.0170(.01\ PI2)$$

$$+.5439(.01\ PEEX2)]$$

see = 2.58 RB2 = .131 dw = .80

7.15 PMEF12 Price index for imports of energy fuels from the United States (SITC 3)

1Q58-4Q68 OLS

J4P[PMEF12/PFX] = - 3.2042
(4.88)

+ 1.7385 J4P[.6005((EC0$2-EC$2)/(EC02-EC2))
(5.43)

+.0846(.01 PPS2)+.0715(.01 PEGF2)

+.0135(.01 PI2)+.2298(.01 PEEX2)]

see = 1.96 RB2 = .398 dw = .72

7.16 PMMF12 Price index for imports of manufactures (excluding transportation equipment) from the United States (SITC 5-8 [excluding transportation equipment])

1Q58-4Q68 OLS

J4P[PMMF12/PFX] = .29588
(1.41)

+ .88885 J4P[.1556((EC0$2-EC$2)/(EC02-EC2))
(7.08)

+.3345(.01 PC2)+.2897(.01 PPD2)

+.0006(.01 PPS2)+.0865(.01 PEGF2)

+.0130(.01 PI2)+.1200(.01 PEEX2)]

+ JW[J4P(PFX)]

t	JW[J4P(PFX)]	
-1	-.09296	(3.17)
-2	-.05229	(3.17)
-3	-.02324	(3.17)
-4	-.00581	(3.17)
Sum W =	-.17430	Z2

see = .665 RB2 = .710 dw = .61

7.17 PGCNWG Price deflator for government current nonwage expenditure

1Q55-4Q68 OLS

PGCNWG = .23032
(1.72)

+ [JW(PCS)][1-(GGSDF-GMPF)/(GCNWF+GCNWPM+GCGSH)]

+ [JW(PMMF12)][(GGSDF-GMPF)/(GCNWF+GCNWPM+GCGSH)]

t		[JW(PCS)][...]		[JW(PMMF12)][...]	
0		.09437	(8.54)	.05925	(2.99)
-1		.15728	(8.54)	.09875	(2.99)
-2		.18873	(8.54)	.11849	(2.99)
-3		.18873	(8.54)	.11849	(2.99)
-4		.15728	(8.54)	.09875	(2.99)
-5		.09437	(8.54)	.05925	(2.99)
Sum W	=	.88076	ZC2	.55298	ZC2

see = .028 RB2 = .955 cov = 2.85% dw = 1.18

7.18 PINRCG Price deflator for government investment in non-residential construction

1Q61-4Q68 OLS

PINRCG = - .20178 + 1.2222 PINRC
(4.04) (26.80)

see = .0202 RB2 = .959 cov = 1.78% dw = .67

7.19 PIMEG Price deflator for government investment in machinery and equipment

1Q61-4Q68 OLS

$$PIMEG = \underset{(11.22)}{.48079} + \underset{(13.15)}{.51628}\ PIME$$

see = .0119 RB2 = .847 cov = 1.14% dw = .81

7.20 PCPI The Consumer Price Index

1Q52-4Q68 OLS

$$\begin{aligned} PCPI = &- \underset{(24.47)}{.09306} + \underset{(288.81)}{1.09195}\ (.051\ PCMV + .062\ PCDO + .308\ PCS \\ &\qquad + .550\ PCNDSD + .029\ PIRC) \\ &+ \underset{(3.85)}{.00210}\ [QC1(.051\ PCMV + .062\ PCDO + .308\ PCS \\ &\qquad + .550\ PCNDSD + .029\ PIRC)] \\ &- \underset{(5.00)}{.00270}\ [QC2(.051\ PCMV + .062\ PCDO + .308\ PCS \\ &\qquad + .550\ PCNDSD + .029\ PIRC)] \\ &- \underset{(1.90)}{.00102}\ [QC3(.051\ PCMV + .062\ PCDO + .308\ PCS \\ &\qquad + .550\ PCNDSD + .029\ PIRC)] \end{aligned}$$

see = .0026 RB2 = .9992 cov = .26% dw = 1.28

Technical Relationships

7.21 PGNE Price deflator for gross national expenditure

PGNE = YGNE/[CNDSD+CS+CMV+CDO+IME+INRC+IRC+IIB+IIF+IIG
+INRCGF+IH+INRCGPM+INRCSM+IMEGF+IMEGPM+X-M
+[(GCNWF+GCNWPM+GCGSH)/PGCNWG]+EG61MPF
+1434.0285 NIS+1297.1399 NGPAF+921.23014
NGPAPM+603.68732[(GWIF+GWIPM)/WQIOS]+ENARES]

7.22 PGPP Price deflator for gross private business product

PGPP = YGPP/[(YGNE/PGNE)-1434.0285 NIS-1297.1399 NGPAF
-921.23014 NGPAPM+ENARES-(YFA/PYFA)
-551.56098 NFP-EG61MPF-603.68732 NIOS]

7.23 PCSMVOD Implicit price deflator for imputed consumer services from the stocks of motor vehicles and of other consumer durables

PCSMVOD = [.06656 J1L[(KMV)(PCMV)+(KDO)(PCDO)]
+.055(CDO)(PCDO)+.0273(CMV)(PCMV)]/CSMVOD

Sector 8. Income Components

8.1 YC Corporate profits before tax

1Q55-4Q68 OLS

$$YC = -\underset{(.97)}{18.532} - \underset{(9.61)}{1.9397}\ (ECINT+CCAC\$)$$

$$+ \underset{(24.73)}{.94608}\ (YGPP-YNFNC-TILGS)$$

$$- \underset{(18.83)}{.95580}\ [(WQMMOB)(NMMOB)+(WQC)(NC)+YWSLP]$$

see = 39.2 RB2 = .990 cov = 3.17% dw = 2.05

8.2 YDIV11 Dividends paid to Canadian residents by Canadian corporations

1Q57-4Q68 OLS

$$YDIV11 = \underset{(138.8)}{.05744}\ J4S[(YC+CCAC\$-TCA)(1-(LDIRV12+LPCV12+LDIPRV13)/KB\$)]$$

$$- \underset{(.26)}{.000194}\ [QC1][J4S([YC+CCAC\$-TCA][1-(LDIRV12+LPCV12+LDIPRV13)/KB\$])]$$

$$- \underset{(4.32)}{.003119}\ [QC2][J4S([YC+CCAC\$-TCA][1-(LDIRV12+LPCV12+LDIPRV13)/KB\$])]$$

$$- \underset{(3.58)}{.002545}\ [QC3][J4S([YC+CCAC\$-TCA][1-(LDIRV12+LPCV12+LDIPRV13)/KB\$])]$$

see = 8.31 RB2 = .979 cov = 5.27% dw = .98

8.3 YDIVF Dividends (before withholding tax) paid to foreign shareholders by Canadian corporations

1Q57-4Q68 OLS

```
YDIVF = .04125 J4S([YC+CCAC$-TCA][(LDIRV12+LPCV12
        (5.33)
                                   +LDIPRV13)/KB$])

    - .00259 [QC1][J4S([YC+CCAC$-TCA][(LDIRV12+LPCV12
      (1.43)
                                   +LDIPRV13)/KB$])]

    - .00693 [QC2][J4S([YC+CCAC$-TCA][(LDIRV12+LPCV12
      (3.08)
                                   +LDIPRV13)/KB$])]

    - .00507 [QC3][J4S([YC+CCAC$-TCA][(LDIRV12+LPCV12
      (2.56)
                                   +LDIPRV13)/KB$])]

    + .27155 J4L(YDIVF)
      (1.87)
```

see = 21.22 RB2 = .859 cov = 12.67% dw = 2.17

Technical Relationships

8.4 YGNE Gross national expenditure

```
YGNE = (CNDSD)(PCNDSD) + (CS)(PCS) + (CMV)(PCMV)
    + (CDO)(PCDO) + (IME)(PIME) + (INRC)(PINRC)
    + (IH)(PIH) + (IRC)(PIRC) + [J1D((PKIB)(KIB))+YIVA]
    + IIF$ + IIG$ + (INRCGF+INRCGPM+INRCSM)(PINRCG)
    + (IMEGF+IMEGPM)(PIMEG) + GCNWF + GCNWPM
    + (NGPAF)(WQGPAF) + GCGSH + GWIF + GWSF
    + (NGPAPM)(WQGPAPM) + GWPASPM + GWIPM + (NIS)(WQISM)
    + GWSSM + GMPF + XBAL$ - TWF - XIH$ - XTRP$
    + MIH$ + MTRP$ + GTNRF + ENARES$
```

8.5 YGPP Gross private business product

$$YGPP = YGNE - (NGPAF)(WQGPAF) - GWSF - (NGPAPM)(WQGPAPM) - GWPASPM - (NIS)(WQISM) - GWSSM - (NFP)(WQF) - GMPF - (NIOS)(WQIOS) + ENARES\$ - YFA$$

8.6 YDW Disposable wage income

$$YDW = YW + GMPF + [1-(TPS/YWAS)](YNFNC) + GTPOF + GTPUIBF + GTPPM - TPS - TRSIGPR - TUIRF - TRHPMPR - TROPMPR - TRFPR - TRHPR - TCPPF - TQPPPM + YPCCB + XTRP\$$$

8.7 YRES Simulation residual defined as zero throughout sample period

$$YRES = YGNE - YW - GMPF - YC + YDIVF - YNFNC - YFA - YIVA - TILGS - CCA\$ + ENARES\$ - YMISC - XID\$12 - XID\$13 + MINT\$12 + MID\$13 + MDIV\$12 - YGIPM - YGIF - YGIH - TCAGBE$$

8.8 YP Personal income

$$YP = YW + GMPF + YF + YNFNC + YRES + GTPOF + GTPUIBF + GTPPM + XTRP\$ + GTPINTF + GTPINTPM + YDIV11 + YPCCB + YMISC + XID\$12 + XID\$13 - MINT\$12 - MID\$13 - MDIV\$12 + YMISCP$$

8.9 YDP Disposable personal income

$$YDP = YP - TPS - TPO - TOPF - TOPPM - TRHPMPR - TROPMPR - TRFPR - TRHPR - TRMVPMPR - TCPPF - TQPPPM - TUIRF$$

8.10 YCR Retained corporate profits

YCR = YC - TCA - YDIVF - YDIV11 - YPCCB + TCAGBE

8.11 YPDNWP Permanent disposable nonwage personal income

YPDNWP = .25 [(J2A[.01 RHOR])(J2A[(VKB)
(1-.01 RVB12-.01 RVB13)])+J4S[XID$12+XID$13
+.01156 J1L([KDO][PCDO]+[KMV][PCMV])]
+.04624(J2A[(8.878 SHM+14.797 SHS)(PIRC)])
+.01(RL-PCPICE)(J2A[VLGB11+LGFTB-LGFTBNR
+ABBCD+ABBCN+ANFCUR-DDGFB+LGFCSB])]
-[.3981 TANW+TOPF+TOPPM+TRMVPMPR-TRSIGPR
-(TPS/YWAS)(YNFNC)]

8.12 YKGP Capital gains, realized and accrued, on equities and bonds

YKGP = J1D[(VKB)(1-.01 RVB12-.01 RVB13)]-(1-.01 RVB12
-.01 RVB13)[J1D[(PKIB)(KIB)]+YIVA+(PIME)(IME
-.05 J1L[KME])+(PINRC)(INRC-.01 J1L[KNRC])]
+(J1D[PLGI])(J2A[LGBF+LGBPM-LGB12-LGB13])

Sector 9. Direct Taxes and Other Current Transfers from Persons

Personal Income Tax

9.1 TPS Personal income tax collections withheld at source

1Q54-4Q68 OLS

$$TPS = \underset{(89.65)}{1.15517}\ JW(TAW) - \underset{(2.19)}{.01428}\ (Q1[JW(TAW)])$$

$$- \underset{(19.20)}{.12669}\ (Q2[JW(TAW)])$$

t	JW(TAW)	(Q1[JW(TAW)])	(Q2[JW(TAW)])
0	.667		
-1	.333	1.0	
-2		1.0	1.0
-3		1.0	1.0
-4		1.0	1.0
-5			1.0

see = 39.23 RB2 = .982 cov = 8.04% dw = 2.30

9.2 TPO Personal income tax collections not withheld at source

1Q54-4Q68 OLS

$$TPO = \underset{(46.30)}{.27166}\ (Q1[JW(TANW)]) + \underset{(138.45)}{.81236}\ (Q2[JW(TANW)])$$

$$+ \underset{(46.63)}{.27360}\ (Q3[JW(TANW)]) + \underset{(40.01)}{.23478}\ (Q4[JW(TANW)])$$

t	(Q1[JW...])	(Q2[JW...])	(Q3[JW...])	(Q4[JW...])
-1	1.0			
-2	1.0	1.0		
-3	1.0	1.0	1.0	
-4	1.0	1.0	1.0	1.0
-5		1.0	1.0	1.0
-6			1.0	1.0
-7				1.0

see = 9.99   RB2 = .994   cov = 6.15%   dw = 1.32

9.3 TPYPM Provincial personal income tax collections

2Q62-4Q68 OLS

TPYPM = 1.09574 JW[(.01 RTPYFB1C)[YWAS1C+YNWAS1C
(55.93)

-(NTW1C)(ZEXYW1C)-(NTNW1C)(ZEXYNW1C)]

+(.01 RTPYFB2C)[YWAS2C+YNWAS2C

-(NTW2C)(ZEXYW2C)-(NTNW2C)(ZEXYNW2C)]

+(.01 RTPYFB3C)[YWAS3C+YNWAS3C

-(NTW3C)(ZEXYW3C)-(NTNW3C)(ZEXYNW3C)]

+(.01 RTPYFB4C)[YWAS4C+YNWAS4C

-(NTW4C)(ZEXYW4C)-(NTNW4C)(ZEXYNW4C)]

-(EYDIVA11)(YDIV11)(.01 RDC)]

t	JW[...]
0	.01(.333 RTPYPXQ+.667 RTPYPQ)
-1	.01[.667 J1L(RTPYPXQ)+.333 J1L(RTPYPQ)]

see = 24.13   RB2 = .966   cov = 10.64%   dw = 2.49

Technical Relationships

9.4 TPYF Federal personal income tax collections

TPYF = TPS + TPO - TPYPM

9.5 TAW Personal income tax accruals on wage income

TAW = [(.01 RTPYFB1C)(RTPSUR)+.01 RTPYF1C][YWAS1C
-(NTW1C)(ZEXYW1C)]
+ [(.01 RTPYFB2C)(RTPSUR)+.01 RTPYF2C][YWAS2C
-(NTW2C)(ZEXYW2C)]
+ [(.01 RTPYFB3C)(RTPSUR)+.01 RTPYF3C][YWAS3C
-(NTW3C)(ZEXYW3C)]
+ [(.01 RTPYFB4C)(RTPSUR)+.01 RTPYF4C][YWAS4C
-(NTW4C)(ZEXYW4C)]

where:

RTPSUR = .01 (RTPYPXQ+RTPYPQ-RFAXQ-RFAQ)

9.6 TANW Personal income tax accruals on nonwage income

TANW = [(.01 RTPYFB1C)(RTPSUR)+.01 RTPYF1C][YNWAS1C
-(NTNW1C)(ZEXYNW1C)]
+ [(.01 RTPYFB2C)(RTPSUR)+.01 RTPYF2C][YNWAS2C
-(NTNW2C)(ZEXYNW2C)]
+ [(.01 RTPYFB3C)(RTPSUR)+.01 RTPYF3C][YNWAS3C
-(NTNW3C)(ZEXYNW3C)]
+ [(.01 RTPYFB4C)(RTPSUR)+.01 RTPYF4C][YNWAS4C
-(NTNW4C)(ZEXYNW4C)]
-(.01 RDC)(EYDIVA11)(YDIV11)(1+RTPSUR)

where:

RTPSUR = .01(RTPYPXQ+RTPYPQ-RFAXQ-RFAQ)

9.7 NT Tax returns filed

NT = 1.2471(NE+NOAPR) - 2.6669

9.8 YWAS Assessed wage income

YWAS = .8399(YW+GMPF-YWSLP-GWSF-GWPASPM-GWSSM)
+ .0045775(YW+GMPF-YWSLP-GWSF-GWPASPM-GWSSM)(QTSTEP)

9.9 YNWAS Assessed nonwage income

YNWAS = .32886(YP-GMPF-YW-YDIV11)
+ .00503153(YP-GMPF-YW-YDIV11)(QTSTEP)
+ (EYDIVA11)(YDIV11)

9.10 NT1C Tax returns filed, income class 1

NT1C = (ENT1C)(NT)

9.11 NT2C Tax returns filed, income class 2

NT2C = (ENT2C)(NT)

9.12 NT3C Tax returns filed, income class 3

NT3C = (ENT3C)(NT)

9.13 NT4C Tax returns filed, income class 4

NT4C = NT - (NT1C+NT2C+NT3C)

9.14 YWAS1C Assessed wage income, income class 1

YWAS1C = (EYWAS1C)(YWAS)

9.15 YWAS2C Assessed wage income, income class 2

YWAS2C = (EYWAS2C)(YWAS)

9.16 YWAS3C Assessed wage income, income class 3

YWAS3C = (EYWAS3C)(YWAS)

9.17 YWAS4C Assessed wage income, income class 4

YWAS4C = YWAS - (YWAS1C+YWAS2C+YWAS3C)

9.18 YNWAS1C Assessed nonwage income, income class 1

YNWAS1C = (EYNWAS1C)(YNWAS)

9.19 YNWAS2C Assessed nonwage income, income class 2

YNWAS2C = (EYNWAS2C)(YNWAS)

9.20 YNWAS3C Assessed nonwage income, income class 3

YNWAS3C = (EYNWAS3C)(YNWAS)

9.21 YNWAS4C Assessed nonwage income, income class 4

YNWAS4C = YNWAS - (YNWAS1C+YNWAS2C+YNWAS3C)

9.22 NTW1C Wage earners tax returns filed, income class 1

NTW1C = [YWAS1C/(YWAS1C+YNWAS1C)](NT1C)

9.23 NTW2C Wage earners tax returns filed, income class 2

NTW2C = [YWAS2C/(YWAS2C+YNWAS2C)](NT2C)

9.24 NTW3C Wage earners tax returns filed, income class 3

NTW3C = [YWAS3C/(YWAS3C+YNWAS3C)](NT3C)

9.25 NTW4C Wage earners tax returns filed, income class 4

NTW4C = [YWAS4C/(YWAS4C+YNWAS4C)](NT4C)

9.26 NTNW1C Nonwage earners tax returns filed, income class 1

NTNW1C = NT1C - NTW1C

9.27 NTNW2C Nonwage earners tax returns filed, income class 2

NTNW2C = NT2C - NTW2C

9.28 NTNW3C Nonwage earners tax returns filed, income class 3

NTNW3C = NT3C - NTW3C

9.29 NTNW4C Nonwage earners tax returns filed, income class 4

NTNW4C = NT4C - NTW4C

Transfers from Persons to Provincial-Municipal Governments

9.30 TRHPMPR Hospital and medical care insurance premiums

1Q60-4Q69 OLS-HL

TRHPMPR = .09292 [QC1(JW[(ERTPHPM)(NL)])]
(4.99)

- .000789 [QC2(JW[(ERTPHPM)(NL)])]
(.04)

- .10785 [QC3(JW[(ERTPHPM)(NL)])]
(6.43)

+ 1.10326 JW[(ERTPHPM)(NL)] + .81714 JW[(ERMEDPM)(NL)]
(48.22) (17.39)

t	JW[(ERTPHPM)(NL)]	JW[(ERMEDPM)(NL)]
0	.667	.667
-1	.333	.333

see = 3.26 RB2 = .974 car = .426 dw = 1.78

9.31 TRMVPMPR Motor vehicle licences and permits, persons

1Q52-4Q68 OLS

$$TRMVPMPR = \underset{(54.84)}{.18554}\ (UKRMVNC)(ERTPMVPM)$$

$$+ \underset{(50.61)}{.29662}\ (QC1[(UKRMVNC)(ERTPMVPM)])$$

$$- \underset{(2.56)}{.01499}\ (QC2[(UKRMVNC)(ERTPMVPM)])$$

$$- \underset{(22.97)}{.13546}\ (QC3[(UKRMVNC)(ERTPMVPM)])$$

see = 2.65   RB2 = .979   cov = 16.15%   dw = 1.58

Technical Relationship

9.32 UKRMVNC Stock of noncommercial registered motor vehicles (million vehicles)

$$UKRMVNC = 1.3191 + .00055667\ KMV + .0012780(KMV)(NU/NL)$$

Corporation Income Tax

9.33 TCA Corporation income tax accruals

1Q53-4Q68 OLS

$$TCA = \underset{(315.91)}{1.01549}\ (.01\ RTCA)(YCT) + TCAPLMT - EDTCA$$

see = 11.94   RB2 = .992   cov = 2.64%   dw = 1.52

9.34 YCT Taxable corporate profits

1Q55-4Q68 OLS

$$YCT = \underset{(2.15)}{108.43} + \underset{(11.05)}{.78556}\ (YC-YPCCB-TCAPLMT)$$

$$+ \underset{(2.52)}{.86722}\ (YC-YPCCB-TCAPLMT)(.01\ RNU)$$

$$- \underset{(2.09)}{.00173}\ (YC-YPCCB-TCAPLMT)(QTIME)$$

$$- \underset{(8.03)}{.66351}\ ECCA63A - \underset{(1.66)}{.19926}\ ECCA66R$$

see = 30.92 RB2 = .983 cov = 3.14% dw = 1.90

9.35 TCAF Federal corporation income tax accruals

1Q53-4Q68 OLS-HL

$$TCAF = \underset{(197.33)}{1.02169}\ (.01\ RTCAF)(YCT) - EDTCA$$

see = 7.36 RB2 = .984 car = .552 dw = 2.13

Technical Relationship

9.36 TCAPM Provincial corporation income tax accruals

TCAPM = TCA - TCAF

Sector 10. Indirect Taxes and Other Government Revenue

10.1 TISF Manufacturers sales tax

1Q55-4Q68 OLS

$$\begin{aligned} \mathrm{TISF} = {} & \underset{(69.48)}{.59372}\,(.01\,\mathrm{RTISFS})[(\mathrm{CNDSD})(\mathrm{PCNDSD})+(\mathrm{CMV})(\mathrm{PCMV}) \\ & +(\mathrm{CDO})(\mathrm{PCDO})] \\ & + \underset{(13.48)}{.46696}\,([.46\,\mathrm{RTISFR}][(\mathrm{INRC})(\mathrm{PINRC}) \\ & +(\mathrm{INRCGF}+\mathrm{INRCGPM}+\mathrm{INRCSM})(\mathrm{PINRCG})+(\mathrm{IH})(\mathrm{PIH})]/ \\ & [100+.46\,\mathrm{RTISFR}]+[.54\,\mathrm{RTISFR}][(\mathrm{IRC})(\mathrm{PIRC})]/ \\ & [100+.54\,\mathrm{RTISFR}]+[.88(.01\,\mathrm{RTISFME}) \\ & +.12(.01\,\mathrm{RTISFS})][(\mathrm{IME})(\mathrm{PIME})+(\mathrm{IMEGF}+\mathrm{IMEGPM}) \\ & (\mathrm{PIMEG})]) \end{aligned}$$

see = 20.40 RB2 = .974 cov = 6.24% dw = 1.77

10.2 TICUSF Customs duties

1Q55-4Q68 OLS

$$\begin{aligned} \mathrm{TICUSF} = {} & -\underset{(1.24)}{11.3488} + \underset{(12.21)}{.11471}\,[\mathrm{MG\$}-(\mathrm{QDCARS})(\mathrm{MMV12})(\mathrm{PMMV12})] \\ & + \underset{(.50)}{.0004097}\,(\mathrm{QC1}[\mathrm{MG\$}-(\mathrm{QDCARS})(\mathrm{MMV12})(\mathrm{PMMV12})]) \\ & - \underset{(2.37)}{.0016753}\,(\mathrm{QC2}[\mathrm{MG\$}-(\mathrm{QDCARS})(\mathrm{MMV12})(\mathrm{PMMV12})]) \\ & + \underset{(.52)}{.0003173}\,(\mathrm{QC3}[\mathrm{MG\$}-(\mathrm{QDCARS})(\mathrm{MMV12})(\mathrm{PMMV12})]) \\ & - \underset{(5.15)}{.006029}\,(\mathrm{QDKEN})[\mathrm{MG\$}-(\mathrm{QDCARS})(\mathrm{MMV12})(\mathrm{PMMV12})] \\ & - \underset{(4.46)}{.0003397}\,(\mathrm{QTIME})[\mathrm{MG\$}-(\mathrm{QDCARS})(\mathrm{MMV12})(\mathrm{PMMV12})] \\ & - \underset{(4.31)}{.38416}\,(\mathrm{QDXINC})(\mathrm{XMV12}) + \underset{(11.14)}{.97596}\,(\mathrm{ESUR})(\mathrm{MG\$}) \end{aligned}$$

where:

MG$ = M$12 + M$13 - MINT$12 - MDIV$12 - MTR$12 - MFS$12
 - MOS$12 - MID$13 - MTR$13 - MFS$13 - MOS$13

see = 4.38   RB2 = .976   cov = 2.95%   dw = 1.43

10.3   TIEXF   Excise taxes and duties (excluding manufacturers sales tax)

1Q55-4Q68   OLS

$$\text{TIEXF} = \underset{(7.47)}{48.981} + \underset{(2.50)}{.02567}\ (\text{QDTIEXF})(\text{CMV})(\text{PCMV})$$

$$+ \underset{(20.43)}{.02776}\ [(\text{CNDSD})(\text{PCNDSD})+(\text{CDO})(\text{PCDO})]$$

see = 8.06   RB2 = .926   cov = 4.92%   dw = 1.83

10.4   TISPM   Retail sales tax

1Q53-4Q68   OLS

$$\text{TISPM} = \underset{(126.33)}{1.07241}\ ([.01\ \text{RTISPM}/(1+.01\ \text{RTISPM})]$$

$$[\text{JW}([\text{CNDSD}][\text{PCNDSD}]+[\text{CMV}][\text{PCMV}]+[\text{CDO}][\text{PCDO}])])$$

t	[JW([CNDSD...])]
0	.667
-1	.333

see = 10.59   RB2 = .990   cov = 8.20%   dw = 2.19

10.5 TIGASPM Gasoline tax

1Q59-4Q68 OLS

$$TIGASPM = \underset{(115.82)}{1.00179}\ [(ERGAS)(EGAS)(UKRMVNC) + (ERDO)(EDO)(.00009392\ KME)]$$

see = 8.40 RB2 = .969 cov = 5.72% dw = 2.11

10.6 TIMVPM Motor vehicle licences and permits, business

1Q52-4Q68 OLS

$$\begin{aligned} TIMVPM = {} & \underset{(40.59)}{.276097}\ [(.00009392\ KME)(ERTIMVPM)] \\ & + \underset{(32.28)}{.386610}\ (QC1[(.00009392\ KME)(ERTIMVPM)]) \\ & + \underset{(1.55)}{.018301}\ (QC2[(.00009392\ KME)(ERTIMVPM)]) \\ & - \underset{(16.29)}{.190882}\ (QC3[(.00009392\ KME)(ERTIMVPM)]) \end{aligned}$$

see = 5.48 RB2 = .952 cov = 21.68% dw = 1.51

10.7 TWF Non-resident withholding tax

1Q61-4Q68 OLS

$$TWF = -\underset{(2.20)}{10.335} + \underset{(10.79)}{.20191}\ (MINT\$12+MDIV\$12+MID\$13)$$

$$-\underset{(.71)}{.00453}\ [QC1(MINT\$12+MDIV\$12+MID\$13)]$$

$$+\underset{(5.11)}{.03207}\ [QC2(MINT\$12+MDIV\$12+MID\$13)]$$

$$-\underset{(3.39)}{.02284}\ [QC3(MINT\$12+MDIV\$12+MID\$13)]$$

see = 4.82 RB2 = .893 cov = 11.83% dw = 1.40

Technical Relationship

10.8 TILGS Indirect taxes less subsidies

$$TILGS = TISF + TICUSF + TIEXF + TISPM + TIGASPM$$
$$+ TIMVPM + TIOF + TIOPM - GSUBSF - GSUBSPM$$

Sector 11. Transfers to Persons

11.1 TUIRF Unemployment Insurance Fund revenue

1Q60-4Q68 OLS

$$TUIRF = \underset{(7.78)}{1.15034}\,[QC1(NEMPS)] - \underset{(11.00)}{1.57257}\,[QC2(NEMPS)]$$

$$+ \underset{(.67)}{.09253}\,[QC3(NEMPS)] + \underset{(236.91)}{19.7740}\,NEMPS$$

$$+ \underset{(12.04)}{5.11389}\,(NEMPS)[J1L(QDUIF)]$$

see = 1.95 RB2 = .974 cov = 2.46% dw = 1.39

11.2 GTPUIBF Unemployment insurance benefits

1Q60-4Q68 OLS

$$GTPUIBF = \underset{(7.07)}{.52977}\,(QC1[(ERUIB)(NCL)])$$

$$+ \underset{(25.47)}{2.50966}\,(QC2[(ERUIB)(NCL)])$$

$$- \underset{(4.84)}{.66232}\,(QC3[(ERUIB)(NCL)])$$

$$+ \underset{(121.17)}{7.54519}\,(ERUIB)(NCL)$$

$$- \underset{(2.64)}{.57772}\,(ERUIB)(NCL)(QDUIF)$$

see = 3.73 RB2 = .995 cov = 3.81% dw = 1.18

11.3 NINS Enrollment in the Unemployment Insurance Fund

1Q60-4Q68 OLS-HL

$$
\begin{aligned}
\text{NINS} = {} & \underset{(1.05)}{.006778}\,[\text{QC1(NE-NEUPF-NEUPB-NFP)}] \\
& + \underset{(.49)}{.00326}\,[\text{QC2(NE-NEUPF-NEUPB-NFP)}] \\
& - \underset{(2.06)}{.015216}\,[\text{QC3(NE-NEUPF-NEUPB-NFP)}] \\
& + \underset{(12.08)}{.810690}\,(\text{NE-NEUPF-NEUPB-NFP}) \\
& - \underset{(1.82)}{.001571}\,(\text{NE-NEUPF-NEUPB-NFP})(\text{QTIME}) \\
& + \underset{(6.16)}{.048135}\,(\text{NE-NEUPF-NEUPB-NFP})(\text{QDUIF}) \\
& + \underset{(.26)}{.044299}\,[\text{QC1(NU)}] - \underset{(1.62)}{.165528}\,[\text{QC2(NU)}] \\
& + \underset{(.42)}{.089613}\,[\text{QC3(NU)}] + \underset{(3.30)}{1.2729}\,\text{NU} + \underset{(1.22)}{.06490}\,\text{QDNINS}
\end{aligned}
$$

see = .0443 RB2 = .975 car = .884 dw = 1.93

11.4 NCL Claimants on the Unemployment Insurance Fund

1Q60-4Q68 OLS

$$
\begin{aligned}
\text{NCL} = {} & - \underset{(4.89)}{.61360} + \underset{(5.31)}{.24623}\,\text{NINS} - \underset{(3.01)}{.01150}\,(\text{NINS})(\text{QDUIF}) \\
& - \underset{(4.83)}{.001246}\,(\text{NINS})(\text{QTIME}) + \underset{(13.63)}{.31833}\,[\text{QC1(NU)}] \\
& - \underset{(3.52)}{.05357}\,[\text{QC2(NU)}] - \underset{(13.55)}{.34011}\,[\text{QC3(NU)}] + \underset{(8.96)}{.68297}\,\text{NU}
\end{aligned}
$$

see = .0169 RB2 = .991 cov = 4.23% dw = 2.27

11.5 GTPINTF Interest on the federal public debt

1Q56-4Q68 OLS

GTPINTF = .995461 [.0025(J2A[(EACR)(LGBF)]
(191.01)

+J2A[(EACRCSB)(LGFCSB)]

+(RS)[J2A(LGFTB)])]

- .04650 (QC1)[.0025(J2A[(EACR)(LGBF)]
(5.09)

+J2A[(EACRCSB)(LGFCSB)]

+(RS)[J2A(LGFTB)])]

+ .04685 (QC2)[.0025(J2A[(EACR)(LGBF)]
(5.15)

+J2A[(EACRCSB)(LGFCSB)]

+(RS)[J2A(LGFTB)])]

+ .03079 (QC3)[.0025(J2A[(EACR)(LGBF)]
(3.41)

+J2A[(EACRCSB)(LGFCSB)]

+(RS)[J2A(LGFTB)])]

+ EIFDMIS

see = 5.77 RB2 = .981 cov = 3.92% dw = 1.88

Technical Relationship

11.6 NEMPS Employed contributors to the Unemployment Insurance Fund

NEMPS = NINS - NCL

Sector 12. Federal Current and Capital Expenditure on Goods and Services

12.1 NGPAF Federal employment in public administration and defence

1Q57-4Q68 OLS

```
100[NGPAF/NPOPT] = 1.87145
                  (11.99)

     - .01528 (QC1[J1L(100[NGPAF/NPOPT])])
       (2.27)

     + .01362 (QC2[J1L(100[NGPAF/NPOPT])])
       (2.06)

     + .02161 (QC3[J1L(100[NGPAF/NPOPT])])
       (3.33)

     + JW[.001 YP/PCPI]

     + JW[(WQGPAF+(GWSF/NGPAF))/(1297.1399 PGCNWG)]

     + JW(.01 RNU) + JW(NPOPT)
```

t	JW[.001 YP/PCPI]		JW[(WQGPAF...)]	
0	.00372	(8.73)	-.23811	(7.80)
-1	.00682	(8.73)	-.13394	(7.80)
-2	.00930	(8.73)	-.05953	(7.80)
-3	.01116	(8.73)	-.01488	(7.80)
-4	.01240	(8.73)		
-5	.01302	(8.73)		
-6	.01302	(8.73)		
-7	.01240	(8.73)		
-8	.01116	(8.73)		
-9	.00930	(8.73)		
-10	.00682	(8.73)		
-11	.00372	(8.73)		
Sum W =	.11282	ZC2	-.44646	Z2

t	JW(.01 RNU)		JW(NPOPT)	
0	.23490	(2.62)	-.00109	(7.25)
-1	.19738	(2.62)	-.00206	(7.25)
-2	.16313	(2.62)	-.00293	(7.25)
-3	.13213	(2.62)	-.00369	(7.25)
-4	.10440	(2.62)	-.00435	(7.25)
-5	.07993	(2.62)	-.00489	(7.25)
-6	.05873	(2.62)	-.00532	(7.25)
-7	.04078	(2.62)	-.00565	(7.25)
-8	.02610	(2.62)	-.00587	(7.25)
-9	.01468	(2.62)	-.00598	(7.25)
-10	.00653	(2.62)	-.00598	(7.25)
-11	.00163	(2.62)	-.00587	(7.25)
-12			-.00565	(7.25)
-13			-.00532	(7.25)
-14			-.00489	(7.25)
-15			-.00435	(7.25)
-16			-.00369	(7.25)
-17			-.00293	(7.25)
-18			-.00206	(7.25)
-19			-.00109	(7.25)
Sum W =	1.06032	Z2	-.08366	ZC2

see = .0215 RB2 = .751 cov = 2.58% dw = 1.75

12.2 WQGPAF Quarterly wage rate in federal public administration and defence

1Q57-4Q68 OLS-HL

$$\ln(\text{WQGPAF+ERPAF}) = -\underset{(.97)}{.49931} + \underset{(.90)}{.001177}\,[\text{QC1}(\ln \text{WQAXF})]$$

$$-\underset{(1.87)}{.002384}\,[\text{QC2}(\ln \text{WQAXF})]$$

$$-\underset{(.68)}{.000871}\,[\text{QC3}(\ln \text{WQAXF})]$$

$$+\ \text{JW}(\ln \text{WQAXF}) + \text{JW}(\ln \text{WQAXF/RNU})$$

where:

WQAXF = [YW-YWSLP-GWSF-GWPASPM-GWSSM-NGPAF(WQGPAF+ERPAF)]/

(NE-NEUPB-NEUPF-NGPAF)

t	JW(ln WQAXF)		JW(ln WQAXF/RNU)	
0	.33912	(14.23)	.00638	(3.23)
-1	.25965	(14.23)	.01117	(3.23)
-2	.19076	(14.23)	.01436	(3.23)
-3	.13247	(14.23)	.01595	(3.23)
-4	.08478	(14.23)	.01595	(3.23)
-5	.04769	(14.23)	.01436	(3.23)
-6	.02120	(14.23)	.01117	(3.23)
-7	.00530	(14.23)	.00638	(3.23)
Sum W =	1.08097	Z2	.09570	ZC2

see = .0419   RB2 = .985   car = .435   dw = 1.77

12.3   GCNWF   Federal current nonwage expenditure

1Q58-4Q68   OLS

$$(GCNWF-CCAGF\$)/PGCNWG = \underset{(.46)}{64.344} + \underset{(12.63)}{77.307}\ QC1$$

$$- \underset{(4.41)}{30.716}\ QC2 - \underset{(4.61)}{37.959}\ QC3 + JW(YP/PCPI)$$

$$+ JW[1297.1399\ PGCNWG/(WQGPAF+(GWSF/NGPAF))]$$

$$+ JW[J4A(.01\ RNU)] + JW(PCPICE) - \underset{(4.90)}{12.337}\ QTIME$$

t	JW(YP/PCPI)		JW[1297.1399...]	
0	.04299	(4.11)	- 73.0478	(1.88)
-1	.02985	(4.11)	- 41.0894	(1.88)
-2	.01911	(4.11)	- 18.2620	(1.88)
-3	.01075	(4.11)	- 4.5655	(1.88)
-4	.00478	(4.11)		
-5	.00119	(4.11)		
Sum W =	.10866	Z2	-136.9647	Z2

t	JW[J4A(.01 RNU)]		JW(PCPICE)	
0	946.046	(3.76)	-16.3504	(2.69)
-1	532.151	(3.76)	- 9.1971	(2.69)
-2	236.512	(3.76)	- 4.0876	(2.69)
-3	59.128	(3.76)	- 1.0219	(2.69)
Sum W =	1773.837	Z2	-30.6569	Z2

see = 17.74   RB2 = .896   cov = 7.44%   dw = 2.54

12.4 INRCGF Federal investment in non-residential construction

1Q59-4Q68 OLS

[INRCGF-.01 J1L(KNRCGF)]/NPOP = 102.24026
(3.14)

- .34601 [QC1(J1L[(INRCGF-.01 J1L[KNRCGF])/NPOP])]
(3.36)

- .06023 [QC2(J1L[(INRCGF-.01 J1L[KNRCGF])/NPOP])]
(.29)

+ .32024 [QC3(J1L[(INRCGF-.01 J1L[KNRCGF])/NPOP])]
(1.73)

+ JW[YP/([PCPI][NPOP])] + JW(NPOP) + JW[J1D(NPOP)]

+ JW[J4A(RNU)/J12A(RNU)] + JW[(J1L[KNRCGF])/NPOP]

t	JW[YP/(...)]		JW(NPOP)	
0	.01860	(6.20)	-1.01791	(6.24)
-1	.01563	(6.20)	- .85533	(6.24)
-2	.01292	(6.20)	- .70688	(6.24)
-3	.01046	(6.20)	- .57257	(6.24)
-4	.00827	(6.20)	- .45240	(6.24)
-5	.00633	(6.20)	- .34637	(6.24)
-6	.00465	(6.20)	- .25448	(6.24)
-7	.00323	(6.20)	- .17672	(6.24)
-8	.00207	(6.20)	- .11310	(6.24)
-9	.00116	(6.20)	- .06362	(6.24)
-10	.00052	(6.20)	- .02828	(6.24)
-11	.00013	(6.20)	- .00707	(6.24)
Sum W =	.08396	Z2	-4.59472	Z2

t	JW[J1D(NPOP)]		JW[J4A(RNU)...]	
0	- 17.80847	(1.39)	3.53375	(4.10)
-1	- 22.88236	(2.28)	2.70553	(4.10)
-2	- 26.76390	(3.22)	1.98773	(4.10)
-3	- 29.45309	(3.89)	1.38037	(4.10)
-4	- 30.94993	(4.12)	.88344	(4.10)
-5	- 31.25441	(4.05)	.49693	(4.10)
-6	- 30.36655	(3.87)	.22086	(4.10)
-7	- 28.28634	(3.68)	.05521	(4.10)
-8	- 25.01377	(3.51)		
-9	- 20.54885	(3.36)		
-10	- 14.89159	(3.24)		
-11	- 8.04197	(3.14)		
Sum W =	-286.26123	Z1Z2	11.26382	Z2

t	JW[(J1L[KNRCGF])/NPOP]	
0	-.07600	(2.98)
-1	-.06156	(2.98)
-2	-.04864	(2.98)
-3	-.03724	(2.98)
-4	-.02736	(2.98)
-5	-.01900	(2.98)
-6	-.01216	(2.98)
-7	-.00684	(2.98)
-8	-.00304	(2.98)
-9	-.00076	(2.98)
Sum W =	-.29260	Z2

see = .533   RB2 = .794   dw = 1.48

Technical Relationship

12.5 KNRCGF Stock of federal non-residential construction

KNRCGF = .99 J1L(KNRCGF) + INRCGF

Sector 13. Provincial-Municipal Current and Capital Expenditure on Goods and Services

13.1 NGPAPM Provincial-municipal employment in public administration

1Q58-4Q68 OLS

$$NGPAPM = \underset{(3.29)}{.06902} - \underset{(8.11)}{.03743}\ (QC1[J1L(NGPAPM)])$$

$$+ \underset{(4.75)}{.02244}\ (QC2[J1L(NGPAPM)])$$

$$+ \underset{(8.33)}{.03722}\ (QC3[J1L(NGPAPM)]) + JW(.001\ YP/PCPI)$$

$$+ JW[(WQGPAPM+(GWPASPM/NGPAPM))/921.23014\ PGCNWG]$$

$$+ JW(RL) + JW[(RABEL-RABELD)/RABEL]$$

$$+ \underset{(2.39)}{.05481}\ J2A[(YTOTPM+GBCPPPM)/(YTOTPM-GBALPM+GALPM)]$$

t	JW(.001 YP/PCPI)		JW[(WQGPAPM...]	
0	.00632	(29.07)	-.06050	(13.79)
-1	.00531	(29.07)	-.03403	(13.79)
-2	.00439	(29.07)	-.01512	(13.79)
-3	.00355	(29.07)	-.00378	(13.79)
-4	.00281	(29.07)		
-5	.00215	(29.07)		
-6	.00158	(29.07)		
-7	.00110	(29.07)		
-8	.00070	(29.07)		
-9	.00039	(29.07)		
-10	.00018	(29.07)		
-11	.00004	(29.07)		
Sum W =	.02852	Z2	-.11343	Z2

t	JW(RL)		JW[(RABEL...)]	
0	-.00142	(1.70)	.01283	(3.36)
-1	-.00099	(1.70)	.00891	(3.36)
-2	-.00063	(1.70)	.00570	(3.36)
-3	-.00035	(1.70)	.00321	(3.36)
-4	-.00016	(1.70)	.00143	(3.36)
-5	-.00004	(1.70)	.00036	(3.36)
Sum W =	-.00359	Z2	.03243	Z2

see = .0037 RB2 = .991 cov = 1.71% dw = 1.45

13.2 WQGPAPM Quarterly wage rate in provincial-municipal public administration

1Q57-4Q68 OLS-HL

$$\ln WQGPAPM = \underset{(3.01)}{1.35125} - \underset{(.52)}{.000563}\,[QC1(\ln WQAXPM)]$$

$$- \underset{(2.40)}{.002559}\,[QC2(\ln WQAXPM)] - \underset{(.18)}{.000196}\,[QC3(\ln WQAXPM)]$$

$$+ JW(\ln WQAXPM) + JW[\ln WQAXPM/RNU]$$

where:

WQAXPM = [YW-YWSLP-GWSF-GWPASPM-GWSSM

-(WQGPAPM)(NGPAPM)+(ERPAF)(NGPAF)]/

(NE-NEUPB-NEUPF-NGPAPM)

t	JW(ln WQAXPM)		JW[ln WQAXPM/RNU]	
0	.17159	(11.70)	.00282	(3.02)
-1	.14418	(11.70)	.00518	(3.02)
-2	.11916	(11.70)	.00706	(3.02)
-3	.09652	(11.70)	.00847	(3.02)
-4	.07626	(11.70)	.00941	(3.02)
-5	.05839	(11.70)	.00988	(3.02)
-6	.04290	(11.70)	.00988	(3.02)
-7	.02979	(11.70)	.00941	(3.02)
-8	.01907	(11.70)	.00847	(3.02)
-9	.01072	(11.70)	.00706	(3.02)
-10	.00477	(11.70)	.00518	(3.02)
-11	.00119	(11.70)	.00282	(3.02)
Sum W =	.77454	Z2	.08567	ZC2

see = .0354 RB2 = .989 car = .464 dw = 1.77

13.3 NIS Employment in elementary and secondary schools under municipal control

1Q57-4Q68 OLS

$$NIS/NPOPS = \underset{(11.91)}{.03322} + \underset{(2.08)}{.0001336}\ QC1 - \underset{(2.93)}{.0004536}\ QC2$$

$$- \underset{(2.73)}{.0002795}\ QC3 + JW(.001\ YP/[(PCPI)(NPOP)])$$

$$+ \underset{(5.76)}{.07321}\ J4A[.001\ GTGMP/NPOPS] + JW(.01\ RL)$$

$$+ JW(.001\ NPOPS) + JW[J1D(NPOPS)]$$

t	JW(.001 YP...)		JW(.01 RL)	
0	.00042	(2.55)	-.00213	(2.39)
-1	.00077	(2.55)	-.00373	(2.39)
-2	.00105	(2.55)	-.00479	(2.39)
-3	.00126	(2.55)	-.00532	(2.39)
-4	.00140	(2.55)	-.00532	(2.39)
-5	.00147	(2.55)	-.00479	(2.39)
-6	.00147	(2.55)	-.00373	(2.39)
-7	.00140	(2.55)	-.00213	(2.39)
-8	.00126	(2.55)		
-9	.00105	(2.55)		
-10	.00077	(2.55)		
-11	.00042	(2.55)		
Sum W =	.01277	ZC2	-.03193	ZC2

t	JW(.001 NPOPS)		JW[J1D(NPOPS)]	
0	-.10413	(1.43)	-.00955	(2.51)
-1	-.08750	(1.43)	-.00875	(2.51)
-2	-.07232	(1.43)	-.00796	(2.51)
-3	-.05858	(1.43)	-.00716	(2.51)
-4	-.04628	(1.43)	-.00636	(2.51)
-5	-.03543	(1.43)	-.00557	(2.51)
-6	-.02603	(1.43)	-.00477	(2.51)
-7	-.01808	(1.43)	-.00398	(2.51)
-8	-.01157	(1.43)	-.00318	(2.51)
-9	-.00651	(1.43)	-.00239	(2.51)
-10	-.00289	(1.43)	-.00159	(2.51)
-11	-.00072	(1.43)	-.00080	(2.51)
Sum W =	-.47005	Z2	-.06205	Z1

see = .00023 RB2 = .989 cov = .58% dw = 1.02

13.4 GCNWPM Provincial-municipal current nonwage expenditure

1Q59-4Q68 OLS

$$(GCNWPM-CCAGPM\$-EMEDPAY)/PGCNWG = \underset{(2.06)}{184.870}$$

$$- \underset{(2.44)}{15.512}\ QC1 - \underset{(2.60)}{16.325}\ QC2 + \underset{(1.69)}{10.570}\ QC3$$

$$+ \underset{(3.45)}{34.234}\ [QC1(QDSEAS)] + \underset{(.51)}{5.0493}\ [QC2(QDSEAS)]$$

$$- \underset{(2.50)}{24.744}\ [QC3(QDSEAS)]$$

$$+ [JW(YP/PCPI)][1+J4A[(YTOTPM+GBCPPPM)/$$

$$(YTOTPM-GBALPM+GALPM)]-.86506]$$

$$+ JW[921.23014\ PGCNWG/(WQGPAPM+(GWPASPM/NGPAPM))]$$

$$+ \underset{(6.17)}{62.121}\ QDCENT$$

t	[JW(YP/PCPI)][...]		JW[921.23014...]	
0	.00238	(4.20)	-51.5288	(1.29)
-1	.00357	(4.20)	-28.9849	(1.29)
-2	.00357	(4.20)	-12.8822	(1.29)
-3	.00238	(4.20)	- 3.2206	(1.29)
Sum W =	.01189	ZC2	-96.6165	Z2

see = 17.71 RB2 = .827 cov = 8.63% dw = 1.69

13.5 INRCGPM Provincial-municipal investment in construction (excluding schools)

1Q60-4Q68 OLS

$$INRCGPM = \underset{(2.19)}{-\ 920.013} - \underset{(19.56)}{.24116}\ (QC1[J1L(INRCGPM)])$$

$$- \underset{(3.72)}{.07065}\ (QC2[J1L(INRCGPM)])$$

$$+ \underset{(20.21)}{.27406}\ (QC3[J1L(INRCGPM)])$$

$$+ JW[J1D((YGNE/PGNE)-IRC-INRC-INRCSM-INRCGF-INRCGPM)]$$

$$+ JW[IRC+INRC+INRCSM+INRCGF]$$

$$+ JW([(YTOTPM+GBCPPPM)/(YTOTPM-GBALPM+GALPM)]/$$

$$J8A[(YTOTPM+GBCPPPM)/(YTOTPM-GBALPM+GALPM)])$$

$$- \underset{(3.40)}{128.211}\ [(RL-PCPICE)/J8A(RL-PCPICE)]$$

t	JW[J1D(...)]		JW[IRC...]	
0	.01168	(2.78)	.01793	(5.13)
-1	.02141	(2.78)	.01507	(5.13)
-2	.02920	(2.78)	.01245	(5.13)
-3	.03503	(2.78)	.01009	(5.13)
-4	.03893	(2.78)	.00797	(5.13)
-5	.04087	(2.78)	.00610	(5.13)
-6	.04087	(2.78)	.00448	(5.13)
-7	.03893	(2.78)	.00311	(5.13)
-8	.03503	(2.78)	.00199	(5.13)
-9	.02920	(2.78)	.00112	(5.13)
-10	.02141	(2.78)	.00050	(5.13)
-11	.01168	(2.78)	.00012	(5.13)
Sum W =	.35423	ZC2	.08094	Z2

t	JW([(YTOTPM...])	
0	38.0384	(2.68)
-1	69.7370	(2.68)
-2	95.0960	(2.68)
-3	114.1152	(2.68)
-4	126.7946	(2.68)
-5	133.1344	(2.68)
-6	133.1344	(2.68)
-7	126.7946	(2.68)
-8	114.1152	(2.68)
-9	95.0960	(2.68)
-10	69.7370	(2.68)
-11	38.0384	(2.68)
Sum W =	1153.8311	ZC2

see = 11.69   RB2 = .967   cov = 4.33%   dw = 1.90

13.6   INRCSM   Municipal investment in school construction

1Q58-4Q68   OLS

INRCSM-.01 J1L(KNRCSM) = - 579.60
(5.53)

- .53128 (QC1[J1L(INRCSM-.01 J1L[KNRCSM])])
(8.34)

+ .19044 (QC2[J1L(INRCSM-.01 J1L[KNRCSM])])
(2.68)

+ .38352 (QC3[J1L(INRCSM-.01 J1L[KNRCSM])])
(8.12)

+ JW(YP/PCPI) + JW(NPOPS) + JW[GTGMP/J12A(GTGMP)]

+ JW[J1L(KNRCSM)]

t	JW(YP/PCPI)		JW(NPOPS)	
0	.00086	(1.88)	20.1368	(3.73)
-1	.00158	(1.88)	16.9205	(3.73)
-2	.00216	(1.88)	13.9839	(3.73)
-3	.00259	(1.88)	11.3269	(3.73)
-4	.00288	(1.88)	8.9497	(3.73)
-5	.00302	(1.88)	6.8521	(3.73)
-6	.00302	(1.88)	5.0342	(3.73)
-7	.00288	(1.88)	3.4960	(3.73)
-8	.00259	(1.88)	2.2374	(3.73)
-9	.00216	(1.88)	1.2586	(3.73)
-10	.00158	(1.88)	.5594	(3.73)
-11	.00086	(1.88)	.1398	(3.73)
Sum W =	.02617	ZC2	90.8952	Z2

t	JW[GTGMP/J12A(GTGMP)]		JW[J1L(KNRCSM)]	
0	.7042	(.07)	-.03062	(2.29)
-1	31.6490	(4.09)	-.02344	(2.29)
-2	50.1690	(5.34)	-.01722	(2.29)
-3	56.2641	(5.42)	-.01196	(2.29)
-4	49.9343	(5.35)	-.00766	(2.29)
-5	31.1796	(5.27)	-.00431	(2.29)
-6			-.00191	(2.29)
-7			-.00048	(2.29)
Sum W =	219.9002	Z1Z2	-.09760	Z2

see = 10.35   RB2 = .889   dw = 1.65

Technical Relationships

13.7 YTOTPM Total provincial-municipal revenue (national accounts basis)

YTOTPM = TPYPM + TQPPPM + TOPPM + TCAPM + TIMVPM + TISPM
+ TIGASPM + TIOPM + TRHPMPR + TRMVPMPR + TROPMPR
+ YGIPM + CCAGPM$ + GTGPMF

13.8 KNRCSM Stock of elementary and secondary schools

KNRCSM = .99 J1L(KNRCSM) + INRCSM

Sector 14. Government Asset and Liability Changes

14.1 TCCF Federal corporation income tax collections

1Q54-4Q68 OLS

```
TCCF = .976354 (Q1)[(.25(QDTCCF1+QDTCCF2+QDTCCF4+QDTCCF5)
       (49.86)
                     +.2727 QDTCCF3+.40 QDTCCF6)(J9W[TCAF])
                     +(QDTCCF7)(.10 J9W[TCAF]+.1667 J5W[TCAF])
                     +(QDTCCF8)(.0833 J9W[TCAF]+.1667 J5W[TCAF])]
     + .992778 (Q2)[(QDTCCF1)(.667 J6W[TCAF]-.667 J3W[TCCF]
       (59.55)
                    -.0833 J10W[TCAF])+(QDTCCF2)(J6W[TCAF]
                    -J3W(TCCF)-.1667 J10W[TCAF]) + (QDTCCF3)
                    (1.0833 J6W[TCAF]-J4W[TCCF]) + (QDTCCF4)
                    (1.0833 J6W[TCAF]-J4W[TCCF]
                    -.0833 J10W[TCAF]) + (QDTCCF5)(J6W[TCAF]
                    -J4W[TCCF] -.0833 J10W[TCAF]) + (QDTCCF6)
                    (1.30 J6W[TCAF] -J4W[TCCF]) + (QDTCCF7)
                    (1.25 J6W[TCAF] -J4W[TCCF]+J1L[TCCF]
                    -.40 J10W[TCAF]) + (QDTCCF8)(1.25 J6W[TCAF]
                    -J4W[TCCF] +J1L[TCCF]-.50 J10W[TCAF])]
     + .975743 (Q3)[(QDTCCF1)(1.1667 J7W[TCAF]-J4W[TCCF]
       (53.72)
                    -.1667 J11W[TCAF]) + (.2727 QDTCCF2
                    +.25(QDTCCF3+QDTCCF4+QDTCCF7+QDTCCF8)
                    +.40 QDTCCF5+.30 QDTCCF6)(J7W[TCAF])]
```

$$+ \underset{(47.72)}{.94091}\ (Q4)[(.25(QDTCCF1+QDTCCF3+QDTCCF4+QDTCCF7+QDTCCF8)+.2727\ QDTCCF2+.20\ QDTCCF5+.30\ QDTCCF6)(J8W[TCAF])]$$

$$- \underset{(7.15)}{114.17}\ QDTCCF9$$

t	J3W	J4W	J5W	J6W	J7W	J8W	J9W	J10W	J11W
-1	1.0	1.0	1.0						
-2	1.0	1.0	1.0	1.0					
-3		1.0	1.0	1.0	1.0				
-4			1.0	1.0	1.0	1.0			
-5				1.0	1.0	1.0	1.0		
-6					1.0	1.0	1.0	1.0	
-7						1.0	1.0	1.0	1.0
-8							1.0	1.0	1.0
-9								1.0	1.0
-10									1.0

see = 25.95   RB2 = .897   cov = 7.34%   dw = 1.33

14.2 PLGF1C   Ratio of market value to book value of Government of Canada direct market issues, maturity class 1

1Q55-4Q68   OLS-HL

$$PLGF1C = \underset{(443.1)}{1.02920}\ [(1+.01\ RS/2)^{**}(-2\ EATM1C)+(EACR1C/RS)(1-[1+.01\ RS/2]^{**}[-2\ EATM1C])]$$

see = .00629   RB2 = .988   car = .646   dw = 2.08

14.3 PLGF2C Ratio of market value to book value of Government of Canada direct market issues, maturity class 2

1Q55-4Q68 OLS-HL

$$PLGF2C = \underset{(495.1)}{1.02466} [(1+.01\ RMS/2)**(-2\ EATM2C)$$
$$+(EACR2C/RMS)(1-[1+.01\ RMS/2]$$
$$**[-2\ EATM2C])]$$

see = .00999 RB2 = .953 car = .344 dw = 1.97

14.4 PLGF3C Ratio of market value to book value of Government of Canada direct market issues, maturity class 3

1Q55-4Q68 OLS-HL

$$PLGF3C = \underset{(359.01)}{1.02451} [(1+.01\ RML/2)**(-2\ EATM3C)$$
$$+(EACR3C/RML)(1-[1+.01\ RML/2]$$
$$**[-2\ EATM3C])]$$

see = .01313 RB2 = .938 car = .356 dw = 1.91

14.5 PLGF4C Ratio of market value to book value of Government of Canada direct market issues, maturity class 4

1Q55-4Q68 OLS-HL

$$PLGF4C = \underset{(231.65)}{1.02709} [(1+.01\ RL/2)^{**}(-2\ EATM4C) + (EACR4C/RL)(1-[1+.01\ RL/2]^{**}[-2\ EATM4C]))]$$

see = ,01563 RB2 = .946 car = .486 dw = 1.98

Technical Relationships

14.6 GBALF Federal national accounts balance (+ if surplus)

GBALF = TPYF + TOPF + TCPPF + TUIRF + TCAF + TWF + TISF
+ TIEXF + TICUSF + TIOF + TRFPR + YGIF + CCAGF$
- (NGPAF)(WQGPAF) - GWIF - GWSF - GCNWF - GMPF
- GTPUIBF - GTPOF - GTPINTF - GTNRF - GSUBSF
- GASSTF - GTGPMF - (INRCGF)(PINRCG) - (IMEGF)(PIMEG)
- IIG$

14.7 GBALPM Provincial-municipal national accounts balance (+ if surplus)

GBALPM = YTOTPM - (NGPAPM)(WQGPAPM) - GWIPM - GWPASPM
- (NIS)(WQISM) - GWSSM - GCNWPM - GTPPM - GSUBSPM
- GASSTPM - GTGHPM - GTPINTPM - (INRCGPM)(PINRCG)
- (INRCSM)(PINRCG) - (IMEGPM)(PIMEG)

14.8 GBALH Hospital national accounts balance (+ if surplus)

GBALH = TRHPR + YGIH + GTGHPM + CCAGH$ - GCGSH - (IH)(PIH)

14.9 LGFTB End-of-quarter stock of Government of Canada treasury bills (excluding Bank of Canada holdings)

LGFTB = J1D(DDGFB) - GBALF - J1D(ANFCUR) - J1D(ABBCD)

- J1D(ABBCN) + (FXO)(PFX) - J1D(LGBF) - TCCF + TCAF

+ GAMIS - J1D(LGFCSB) + J1L(LGFTB)

14.10 PLGI Market valuation ratio for Government of Canada, provincial and municipal bonds held by Canadian residents

PLGI = (EWLF)([(PLGF1C)(LGBFR1C)+(PLGF2C)(LGBFR2C)

+(PLGF3C)(LGBFR3C)+(PLGF4C)(LGBFR4C)]/

[LGBFR1C+LGBFR2C+LGBFR3C+LGBFR4C])

+ (1-EWLF)(.20 PLGF1C+.14 PLGF2C+.33 PLGF3C

+.33 PLGF4C)

14.11 GBRPM Gross new issues of provincial and municipal bonds (excluding provincial issues to Canada Pension Plan Investment Fund)

GBRPM = GALPM + GBRETSPM - GBCPPPM - GBALPM

14.12 LGBPM End-of-quarter stock of provincial and municipal bonds, direct and guaranteed (excluding provincial issues to Canada Pension Plan Investment Fund)

LGBPM = J1L(LGBPM) + GBRPM - GBRETSPM

14.13 UGNWNH Government nonwage expenditure (excluding current expenditure by hospitals) (1961 dollars)

UGNWNH = IIG + INRCGPM + IMEGF + INRCSM + IMEGPM

+ INRCGF + IH + (GCNWF+GCNWPM)/(PGCNWG)

Sector 15. Demand for Liquid Assets by Nonfinancial Sector

(See table following for equations 15.1-15.8)

15.1	ANFCUR	Currency outside chartered banks held by nonfinancial public
15.2	DPB	Personal savings and personal chequing accounts in chartered banks
15.3	DSTL	Chequable and nonchequable demand and savings deposits in trust and loan companies
15.4	LGFCSB	End-of-quarter stock of Canada Savings Bonds
15.5	DDB	Demand deposits in chartered banks (excluding float, Government of Canada deposits and personal chequing accounts)
15.6	DSWPB	Swapped deposits in chartered banks
15.7	DNPTB	Nonpersonal term and notice deposits in chartered banks
15.8	DTTL	Receipts and guaranteed investment certificates deposited in trust and loan companies

Technical Relationships

15.9 ANFGN Government of Canada, provincial and municipal debt less chartered bank day, call and short loans held by nonfinancial public

ANFGN = LGBPM + LGBF + LGFTB + LGBFG - LGB12 - LGB13

- LGFTBNR - ABELCD - ABLGBPM

15.10 ANFLIQ Liquid assets held by nonfinancial public

ANFLIQ = ANFCUR + DPB + DSTL + LGFCSB + DDB + DSWPB

+ DNPTB + DTTL + ANFGN

15.11 DCDPB Canadian dollar deposits in chartered banks (excluding Government of Canada deposits)

DCDPB = DDB + DNPTB + DPB

Equations 15.1-15.8

DEMAND FOR LIQUID ASSETS BY NONFINANCIAL SECTOR
(Estimated as a proportion of ANFLIQ)

[2Q56-4Q68 OLS (Constrained)]

	ANFCUR	DPB	DSTL	LGFCSB	DDB	DSWPB	DNPTB	DTTL	ANFGN	Sum Across Equations
Constant	.05977 (3.53)	.20046 (5.94)	-.00388 (.57)	.08349 (7.01)	.32382 (6.43)		.09296 (2.83)	.01329 (3.28)	.23009 (10.18)	1
QC1	.00312 (3.49)	.00916 (5.13)	-.00083 (.87)	-.00288 (2.04)	.00121 (.42)		.00674 (3.66)	.00426 (3.98)	-.02078 (5.64)	0
QC2	.00386 (5.92)	.00442 (3.31)	-.00061 (.83)	-.00368 (3.35)	.00525 (2.48)		.00430 (3.15)	.00213 (2.63)	-.01567 (5.70)	0
-.333[QC1+QC2+QC3] (4th quarter seasonal)	.00697 (4.70)	.00696 (2.30)	-.00166 (1.00)	.00434 (1.76)	.00795 (1.64)		.00918 (2.93)	.00548 (2.95)	-.03922 (6.16)	0
QDB						.00342 (6.71)	.00188 (1.49)		-.00530 (3.88)	0
QDBA					.00047 (.27)		.00581 (5.39)		-.00628 (3.24)	0
YGNE/ANFLIQ	.07139 (4.95)	.14248 (4.92)	-.01541 (1.02)	-.11639 (5.06)	.19849 (4.28)		.14426 (4.65)	.06190 (3.41)	-.48672 (8.00)	0
1000/ANFLIQ	.47687 (8.10)	-.27600 (1.93)	-.01229 (.17)	-.36978 (3.49)	.24861 (2.63)		-.40068 (4.01)	-.72345 (9.03)	1.05672 (6.21)	0
RPD		.01144 (6.53)	-.00209 (2.36)	-.00601 (5.09)					-.00334 (1.64)	0
RSTL		-.00609 (4.97)	.00609 (4.97)							0
EACRCSB		-.00215 (2.63)		.00215 (2.63)						0
RNPT							.00230 (2.17)		-.00230 (2.17)	0
QDB(RNPT-RSWP)						-.00200 (2.53)	.00200 (2.53)			
RTTL								.00373 (6.85)	-.00373 (6.85)	0
RS		-.00119 (3.01)			-.00312 (4.54)		-.00342 (2.73)	-.00302 (7.79)	.01075 (7.16)	0
QDB(RNPT-RS)							.00243 (1.33)		-.00243 (1.33)	0
J1L(ANFCUR)/ANFLIQ	-.42093 (5.44)	.42093 (5.44)								0
J1L(ANFLIQ)/ANFLIQ	-.05552 (3.13)	-.18917 (5.61)			-.34836 (7.15)		-.11027 (3.11)			-.70332
Lagged dep. var. ANFLIQ	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332 (26.16)	.70332
R2	.957	.959	.977	.979	.860	.922	.989	.997	.989	
dw	1.27	1.37	0.90	1.23	1.61	1.79	1.89	1.53	1.71	

Sector 16. Chartered Bank Assets

16.1 DSTATB Statutory deposits in chartered banks

1Q55-4Q68 OLS

$$DSTATB = \underset{(8.22)}{647.60} - \underset{(4.58)}{.01202}\,[QC1(DCDPB+DDGFB)]$$

$$+ \underset{(1.23)}{.00293}\,[QC2(DCDPB+DDGFB)]$$

$$+ \underset{(2.64)}{.00619}\,[QC3(DCDPB+DDGFB)] + \underset{(6.77)}{.55002}\,(DCDPB+DDGFB)$$

$$+ \underset{(5.25)}{.44702}\,J1L(DCDPB+DDGFB)$$

see = 149.32 RB2 = .999 cov = 1.02% dw = 1.32

16.2 ABBCN Bank of Canada notes held by chartered banks

1Q55-4Q68 OLS

$$ABBCN = \underset{(3.11)}{68.330} - \underset{(4.68)}{.02258}\,[QC1(ANFCUR)]$$

$$- \underset{(.82)}{.00448}\,[QC2(ANFCUR)] - \underset{(2.01)}{.00791}\,[QC3(ANFCUR)]$$

$$+ \underset{(11.19)}{.12439}\,ANFCUR - \underset{(3.36)}{.41235}\,J1D(ANFCUR)$$

see = 31.40 RB2 = .815 cov = 10.04% dw = .82

16.3 ABSTATN Bank of Canada notes held by chartered banks on a statutory basis

1Q55-4Q68 OLS

$$ABSTATN = \underset{(2.15)}{53.913} - \underset{(2.16)}{.09104}\ [QC1(ABBCN)]$$

$$+ \underset{(3.85)}{.10190}\ [QC2(ABBCN)] + \underset{(3.08)}{.08217}\ [QC3(ABBCN)]$$

$$+ \underset{(4.71)}{.57744}\ ABBCN + \underset{(4.05)}{.50696}\ J1L(ABBCN)$$

see = 31.06 RB2 = .772 cov = 8.00% dw = .43

16.4 RBCR Required cash reserve ratio of chartered banks

$$RBCR = [(ERBCRDD)(J2A[DDB+DDGFB])+(16-ERBCRDD)(J2A[DPB+DNPTB])$$
$$+(2\ ERBCRDD-16)(.01\ ERBPCA)(J2A[DPB])]/$$
$$[J2A(DCDPB+DDGFB)]$$

16.5 ABLP Chartered bank personal loans

2Q56-4Q68 OLS

$$J1D(ABLP) = - \underset{(8.08)}{162.75} - \underset{(3.66)}{.01614}\ (QC1[J1L(ABLP)])$$

$$+ \underset{(5.77)}{.02473}\ (QC2[J1L(ABLP)]) - \underset{(1.13)}{.00451}\ (QC3[J1L(ABLP)])$$

$$+ \underset{(6.76)}{371.99}\ J1L[(RABEL-RABELD)/RABEL]$$

$$+ \underset{(7.80)}{.16492}\ [(PCMV)(CMV)+(PCDO)(CDO)]$$

see = 34.92 RB2 = .816 dw = 1.32

16.6 ABLB Chartered bank business and miscellaneous general loans

2Q56-4Q68 OLS

```
J1D(ABLB) = - 210.35 - .01634 (QC1[J1L(ABLB)])
              (3.48)   (3.50)

    + .02706 (QC2[J1L(ABLB)]) + .00622 (QC3[J1L(ABLB)])
      (6.30)                    (1.49)

    + JW[(RABEL-RABELD)/RABEL]

    + .15602 [(PIME)(IME)+(PINRC)(INRC)
      (3.44)

             +J1D([PKIB][KIB])+YIVA

             -(YCR+CCAC$+TCAF-TCCF)]

    + .17391 (QDBA)[(PIME)(IME)+(PINRC)(INRC)
      (3.11)

             +J1D([PKIB][KIB])+YIVA

             -(YCR+CCAC$+TCAF-TCCF)]

    - 390.86 J1L(QCRISIS)
      (6.31)
```

t	JW[(RABEL...]	
0	157.26	(5.41)
-1	251.61	(5.41)
-2	283.07	(5.41)
-3	251.61	(5.41)
-4	157.26	(5.41)
Sum W =	1100.81	ZC2

see = 91.09 RB2 = .687 dw = 2.02

Technical Relationships

16.7 ABBCD Bank of Canada deposits held by chartered banks

ABBCD = (.01 RBCR)(DSTATB) + ABEC - ABSTATN

16.8 ABEL Chartered bank earning liquid assets

ABEL = ABT - ABBCD - ABBCN - ABLB - ABLP - ABLM - ABLGBPM - ABLO - ABSC

16.9 ABELCD Chartered bank Canadian dollar earning liquid assets

ABELCD = ABEL - ABELNF

16.10 ABT Chartered bank total assets

ABT = DCDPB + DDGFB + LONB

16.11 RABEL Earning liquid asset ratio of chartered banks

RABEL = [ABEL-(.01 ZRBSR)(DSTATB)]/ABT

Sector 17. Interest Rates and Mortgage Approvals

17.1 RS Average yield on Government of Canada bonds, 1-3 years

1Q58-4Q68 OLS

RS = .59756 + .05856 QC1 − .15319 QC2 − .01290 QC3
(2.55) (.74) (2.05) (.18)

+ .38703 J1L(RS) + .49045 (RTB2)(QFLEX)
(4.76) (4.90)

+ .62951 QCRISIS + .29696 (RTB2)(1-QFLEX)
(3.66) (3.38)

+ JW[J1P(ABLP+ABLB)] + JW[J1P(PCPI)] + .07086 J1P(LGBF)
(2.62)

t	JW[J1P(ABLP+ABLB)]		JW[J1P(PCPI)]	
0	.08121	(5.76)	.18360	(3.42)
−1	.05639	(5.76)	.16065	(3.42)
−2	.03609	(5.76)	.13770	(3.42)
−3	.02030	(5.76)	.11475	(3.42)
−4	.00902	(5.76)	.09180	(3.42)
−5	.00226	(5.76)	.06885	(3.42)
−6			.04590	(3.42)
−7			.02295	(3.42)
Sum W =	.20528	Z2	.82621	Z1

see = .250 RB2 = .930 cov = 5.40% dw = 1.49

17.2 RL Average yield on Government of Canada bonds, 10 years and over

1Q57-4Q68 OLS

$$RL = \underset{(2.71)}{.60845} + \underset{(6.04)}{.40041}\ RS + \underset{(1.79)}{.14894}\ (RTB2-RS)$$

$$+ \underset{(1.46)}{.13254}\ (RCB2-RTB2) + \underset{(2.59)}{.19975}\ PCPICE$$

$$+ \underset{(1.04)}{.05804}\ J1D(LGBFR4C/LGBFR1C) + JW(RS)$$

t	JW(RS)	
-1	-.01596	(.89)
-2	.00548	(.45)
-3	.02044	(1.89)
-4	.03033	(2.83)
-5	.03641	(3.49)
-6	.03977	(4.14)
-7	.04131	(4.91)
-8	.04179	(5.88)
-9	.04177	(7.11)
-10	.04165	(8.61)
-11	.04165	(10.31)
-12	.04183	(11.64)
-13	.04208	(11.29)
-14	.04211	(9.35)
-15	.04146	(7.34)
-16	.03950	(5.88)
-17	.03543	(4.88)
-18	.02828	(4.20)
-19	.01691	(3.72)
Sum W =	.61224	Z1Z2Z3Z4

see = .096   RB2 = .982   cov = 1.84%   dw = 1.25

17.3 RML Average yield on Government of Canada bonds, 5-10 years

1Q57-4Q68 OLS

$$RML = \underset{(.70)}{.19023} + \underset{(9.05)}{.73265}\ RS + \underset{(3.01)}{.29945}\ (RTB2-RS)$$

$$+ \underset{(2.10)}{.22945}\ (RCB2-RTB2) + \underset{(2.13)}{.20112}\ PCPICE + JW(RS)$$

t	JW(RS)	
-1	.00028	(.01)
-2	.00528	(.35)
-3	.00756	(.57)
-4	.00814	(.62)
-5	.00788	(.62)
-6	.00746	(.64)
-7	.00744	(.73)
-8	.00820	(.95)
-9	.00995	(1.39)
-10	.01276	(2.16)
-11	.01653	(3.36)
-12	.02102	(4.79)
-13	.02582	(5.68)
-14	.03034	(5.53)
-15	.03387	(4.94)
-16	.03552	(4.35)
-17	.03423	(3.89)
-18	.02882	(3.54)
-19	.01792	(3.26)
Sum W =	.31902	Z1Z2Z3Z4

see = .117 RB2 = .980 cov = 2.31% dw = 1.17

17.4 RMS Average yield on Government of Canada bonds, 3-5 years

1Q57-4Q68 OLS

$$RMS = -\underset{(.53)}{.12432} + \underset{(23.50)}{1.0221}\ RS + \underset{(6.35)}{.44871}\ (RTB2-RS) + \underset{(5.46)}{.44932}\ (RCB2-RTB2) + JW(RS)$$

t	JW(RS)	
-1	.01099	(.77)
-2	.00132	(.16)
-3	-.00542	(1.45)
-4	-.00957	(3.13)
-5	-.01148	(2.44)
-6	-.01147	(1.91)
-7	-.00989	(1.50)
-8	-.00708	(1.07)
-9	-.00337	(.55)
-10	.00090	(.17)
-11	.00539	(1.11)
-12	.00977	(2.11)
-13	.01369	(2.80)
-14	.01682	(3.09)
-15	.01881	(3.15)
-16	.01934	(3.11)
-17	.01806	(3.05)
-18	.01464	(2.98)
-19	.00873	(2.92)
Sum W =	.08018	Z2Z3

see = .175 RB2 = .956 cov = 3.59% dw = 1.13

17.5 RNPT Rate on nonpersonal term and notice deposits in chartered banks

1Q55-4Q68 OLS

$$RNPT = -\underset{(3.91)}{.77634} + \underset{(19.18)}{.97851}(1-QDB)(RS) + \underset{(5.96)}{.76684}(QDB)(RS)$$

$$+ \underset{(2.75)}{.35750}(QDB)[J1L(RS)]$$

see = .323 RB2 = .943 cov = 8.43% dw = .99

17.6 RSWP Rate on swapped deposits in chartered banks

1Q62-4Q68 OLS

$$RSWP = \underset{(2.82)}{.45843} + \underset{(29.07)}{.84669}\left[REUR-\left(\frac{PFX-PFXF}{PFX}\right)(405.5)\right]$$

see = .195 RB2 = .969 cov = 3.86% dw = 2.15

17.7 RTTL Rate on one-year deposits in trust companies

1Q54-4Q68 OLS

$$RTTL = \underset{(2.10)}{.23010} + \underset{(9.71)}{.47517}\, RS - \underset{(2.15)}{.15365}\, J1L(RS) + \underset{(9.82)}{.66819}\, J1L(RTTL)$$

see = .181 RB2 = .972 cov = 3.87% dw = 2.14

17.8 RMC Conventional mortgage rate

1Q57-4Q68 OLS

$$RMC = \underset{(3.12)}{1.2376} - \underset{(1.91)}{.05242}\, QC1 + \underset{(1.50)}{.04768}\, QC2 + \underset{(.10)}{.00261}\, QC3$$
$$- \underset{(4.34)}{3.3352}\, [(HAPTL+HAPLI+HAPB+HAPCMHCS+HAPCMHCM)/([PIRC][NHH])]$$
$$- \underset{(.17)}{.01672}\, [(J1L[SHM+SHS])/NHH]$$
$$+ \underset{(1.78)}{.10301}\, (QNHA)(RL+2.25-RNHA)$$
$$- \underset{(4.75)}{.47334}\, QNHA + JW[YDP/([NHH][PGNE])] + \underset{(9.89)}{.72467}\, J1L(RMC)$$

t	JW[YDP/([NHH][PGNE])]	
0	.35723	(3.83)
-1	.26792	(3.83)
-2	.17861	(3.83)
-3	.08931	(3.83)
Sum W =	.89307	Z1

see = .097 RB2 = .978 cov = 1.33% dw = 1.56

17.9 HAPTL Trust and loan company mortgage approvals

1Q57-4Q68 OLS

HAPTL = 10.694 - .00042 [QC1(ATL)] + .01049 [QC2(ATL)]
(.84) (.17) (4.61)

- .00116 [QC3(ATL)] + .00782 [J1L(.5[RMC+RNHA]-RL)][ATL]
(.51) (1.31)

+ .00463 ATL + .20194 J4D(ATL) + JW(HAPTL)
(.27) (3.71)

t		JW(HAPTL)	
-1		.13700	(1.19)
-2		.05664	(.78)
-3		-.00345	(.07)
-4		-.04329	(.91)
-5		-.06285	(1.30)
-6		-.06217	(1.45)
-7		-.04121	(1.52)
Sum W	=	-.01934	Z1Z2

see = 39.24 RB2 = .858 cov = 20.92% dw = 1.88

17.10 HAPLI — Life insurance company mortgage approvals

1Q56-4Q68 OLS

$$\text{HAPLI} = \underset{(.43)}{9.6617} - \underset{(3.05)}{.00229}\,[\text{QC1(ALI-APLLI)}]$$

$$+ \underset{(6.42)}{.00465}\,[\text{QC2(ALI-APLLI)}] + \underset{(.57)}{.00042}\,[\text{QC3(ALI-APLLI)}]$$

$$- \underset{(1.87)}{.00403}\,\text{(QNHA)(RL+2.25-RNHA)(ALI-APLLI)}$$

$$+ \underset{(4.95)}{.02358}\,\text{(ALI-APLLI)} - \underset{(5.52)}{3.3714}\,\text{J4D(APLLI)}$$

$$+ \underset{(.20)}{.00025}\,\text{(1-QNHA)(J1L[.5(RMC+RNHA)-RL])(ALI-APLLI)}$$

$$+ \text{JW(HAPLI)}$$

t	JW(HAPLI)	
-1	.15748	(2.07)
-2	.10079	(2.07)
-3	.05669	(2.07)
-4	.02520	(2.07)
-5	.00630	(2.07)
Sum W =	.34646	Z2

see = 27.22 RB2 = .812 cov = 14.59% dw = 2.20

Technical Relationship

17.11 ATL — Assets of trust and loan companies

ATL = DSTL + DTTL + LONTL

Sector 18. The Market Value of Real Capital, Wealth, the Supply Price of Capital and the Expected Rate of Inflation

18.1 VKB — The difference between the long-term interest rate and the normalized yield on the market value of business capital stock used to solve for VKB - the market value of the end-of-quarter business capital stock

1Q55-4Q68 OLS

RL-100[J4S(YC-TCA+ECINT+YCGBE+YNFNC-[WQMMOB][NEUPB])/J2A(VKB)]

2.0282 + PCPICE - .91220 [([.01 PCPICE][J2A(VKB)]
(3.35) (5.11)

+J4S[YC-TCA+ECINT+YCGBE

+YNFNC-(WQMMOB)(NEUPB)])/

J4S(GTPINTF+GTPINTPM-EIFDMIS)]

see = .511 RB2 = .786 dw = .60

Technical Relationships

18.2 PCPICE — Expected annual rate of change in the Consumer Price Index (Weights derived in the estimation of 18.1)

PCPICE = JW[J4P(PCPI)]

t	JW[J4P(PCPI)]	
0	.15771	(.93)
-1	.06334	(.92)
-2	.01127	(.25)
-3	-.00678	(.10)
-4	.00096	(.01)
-5	.02621	(.37)
-6	.06073	(1.10)
-7	.09626	(2.76)
-8	.12453	(2.75)
-9	.13730	(2.47)
-10	.12630	(2.18)
-11	.08329	(1.99)
Sum W =	.88113	Z1Z2Z3

18.3 VLGB11 Market value of resident-held Government of Canada, provincial and municipal bonds

VLGB11 = (PLGI)(LGBF+LGBPM-LGB12-LGB13)

18.4 V Market value of private sector wealth

V = (VKB)(1-.01 RVB12-.01 RVB13) + A12 + A13 + (KMV)(PCMV)
+ (KDO)(PCDO) + (14.797 SHS+8.878 SHM)(PIRC)
+ VLGB11 + ABBCD + ABBCN + ANFCUR + LGFCSB
+ LGFTB - LGFTBNR - DDGFB

18.5 RHOR Approximation to the real supply price of capital

RHOR = .5(100[J4S(YC-TCA+ECINT+YCGBE+YNFNC-[WQMMOB][NEUPB])/
J2A(VKB)] + RL - 2.0282 - PCPICE
+ .91220 [([.01 PCPICE][J2A(VKB)]+J4S[YC-TCA+ECINT
+YCGBE+YNFNC-(WQMMOB)(NEUPB)])/J4S(GTPINTF
+GTPINTPM-EIFDMIS)])

18.6 RHO Approximation to the nominal supply price of capital

RHO = RHOR + PCPICE

18.7 KB$ The replacement value of the business capital stock

KB$ = (PKIB)(KIB) + (PIME)(KME) + (PINRC)(KNRC)

Sector 19. Long-Term Capital Flows

19.1 FIDI12 Direct investment in Canada from the United States

1Q57-4Q68 OLS

$$\frac{\text{FIDI12}}{\text{[J4A[(IME)(PIME)+(INRC)(PINRC)-YCR-CCAC\$]][LDIRV12/KB\$]}} =$$

$$\underset{(4.97)}{.56838} - \underset{(.13)}{.00515}\ \text{QC1} + \underset{(.35)}{.01428}\ \text{QC2} - \underset{(1.65)}{.06615}\ \text{QC3}$$

$$-\underset{(2.40)}{.03512}\ \text{EGUIDE} - \underset{(3.59)}{.26066}\ \text{ZDEPREC} + \text{JW[RHO-RHO2]}$$

$$-\underset{(4.17)}{.95082}\ [(\text{EPS\$2+EPD\$2-YPCC\$2+YDV\$2})/(\text{SA\$2-YCR\$2})]$$

t		JW[RHO-RHO2]	
-1		.01871	(.70)
-2		.03203	(2.80)
-3		.03654	(4.62)
-4		.03441	(3.49)
-5		.02780	(2.84)
-6		.01889	(2.49)
-7		.00984	(2.29)
-8		.00282	(2.15)
Sum W	=	.18106	Z2Z3

see = .161 RB2 = .510 cov = 27.46% dw = 1.72

19.2 FIDI13 Direct investment in Canada from other countries

2Q58-4Q68 OLS

$$\frac{FIDI13}{[J12A[(IME)(PIME)+(INRC)(PINRC)-YCR-CCAC\$]][LDIPRV13/KB\$]} =$$

$$\underset{(1.46)}{.21574} + JW[RHO-RLUK] + \underset{(7.04)}{2.18859}\ QOIL$$

t	JW[RHO-RLUK]	
0	-.00997	(.63)
-1	-.00230	(.19)
-2	.00430	(.47)
-3	.00983	(1.41)
-4	.01428	(2.40)
-5	.01767	(2.99)
-6	.01999	(3.15)
-7	.02124	(3.11)
-8	.02141	(3.02)
-9	.02052	(2.93)
-10	.01856	(2.85)
-11	.01552	(2.78)
-12	.01142	(2.72)
-13	.00624	(2.67)
Sum W =	.16871	Z1Z2

see = .300 RB2 = .577 cov = 46.71% dw = 1.42

19.3 FODI12 Direct investment in the United States from Canada

1Q57-4Q68 OLS

$$\frac{FODI12}{J4A([PFX][EPD\$2+EPS\$2-YPCC\$2+YDV\$2])} = \underset{(3.01)}{.67922} + \underset{(1.42)}{.55004}\ QC1$$

$$- \underset{(1.68)}{.65291}\ QC2 - \underset{(1.16)}{.46445}\ QC3 - \underset{(4.48)}{7.2315}\ QSALE$$

see = 1.55 RB2 = .362 dw = 2.61

19.4 FOL13 Long-term direct and portfolio investment in bonds and shares from Canada in other countries

1Q60-4Q68 OLS

$$FOL13 = \underset{(2.45)}{.002794}\ J1D(V) + \underset{(3.66)}{45.178}\ EF68E$$

$$+\ JW(J1D[(.01\ XBCF2)e^{**}(4.167641+.01341\ QTIME)])$$

t	JW(J1D[...])	
0	.38368	(.63)
-1	.49328	(1.03)
-2	.58748	(1.61)
-3	.66628	(2.48)
-4	.72968	(3.68)
-5	.77767	(4.77)
-6	.81026	(4.88)
-7	.82745	(4.32)
-8	.82924	(3.74)
-9	.81563	(3.29)
-10	.78661	(2.96)
-11	.74219	(2.72)
-12	.68237	(2.53)
-13	.60715	(2.38)
-14	.51652	(2.26)
-15	.41049	(2.17)
-16	.28907	(2.09)
-17	.15223	(2.02)
Sum W =	11.10728	Z1Z2

see = 14.29 RB2 = .306 cov = 55.97% dw = 1.97

19.5 FINIPM12 Sales of gross new issues of provincial and municipal bonds, direct and guaranteed, in the United States

3Q55-4Q68 OLS

$$\frac{FINIPM12}{GBRPM} = \underset{(7.51)}{.29660} + \underset{(2.94)}{.06446}\,QC1 + \underset{(.89)}{.01952}\,QC2 - \underset{(.57)}{.01220}\,QC3$$

$$- \underset{(5.12)}{.17906}\,QLOBO + JW[(RABEL-RABELD)/RABEL]$$

$$+ \underset{(2.49)}{.21495}\,EIETB$$

t	JW[(RABEL...]	
0	-.20322	(1.89)
-1	-.08518	(1.73)
-2	-.00583	(.11)
-3	.03481	(.57)
-4	.03676	(.81)
Sum W =	-.22265	Z1Z2

see = .092 RB2 = .486 cov = 42.01% dw = 1.70

19.6 FINIB12 Sales of gross new issues of Canadian corporate bonds in the United States

3Q55-4Q68 OLS

$$\frac{\text{FINIB12}}{\text{J12A[(IME)(PIME)+(INRC)(PINRC)-YCR-CCAC\$]}} = \underset{(4.79)}{.98082}$$

$$- \underset{(.003)}{.00010}\ \text{QC1} + \underset{(2.84)}{.10716}\ \text{QC2} - \underset{(1.65)}{.06096}\ \text{QC3} - \underset{(4.88)}{.36335}\ \text{QFLEX}$$

$$- \underset{(2.78)}{.000364}\ \text{J1L(LCB12/VCN\$2)} + \text{JW[(RABEL-RABELD)/RABEL]}$$

$$+ \underset{(3.17)}{.47101}\ \text{EIETB}$$

t	JW[(RABEL...]	
0	-.18550	(.95)
-1	-.23417	(2.61)
-2	-.23996	(2.31)
-3	-.20286	(1.69)
-4	-.12288	(1.40)
Sum W =	-.98538	Z1Z2

see = .158 RB2 = .416 cov = 73.68% dw = 1.82

19.7 FITOGB12 Trade in outstanding Government of Canada, provincial and municipal bonds between Canada and the United States (net sales to the United States)

1Q55-4Q68 OLS

$$\text{FITOGB12} = \underset{(.79)}{9.5312} + \underset{(7.27)}{56.837}\ \text{(RL-RCB2)}$$

$$- \underset{(3.22)}{.02655}\ \text{J1L(LGB12/VCN\$2)}$$

see = 14.01 RB2 = .481 dw = 1.18

19.8 FITOBB12 Trade in outstanding Canadian corporate bonds between Canada and the United States (net sales to the United States)

1Q55-4Q68 OLS

$$\underset{(3.92)}{\text{FITOBB12} = 206.20}\ (\text{PFX-EPFXE}) + \underset{(3.01)}{6.1187}\ (\text{RL-RCB2})$$

$$- \underset{(3.55)}{.004034}\ \text{J1L(LCB12/VCN\$2)} - \underset{(1.99)}{5.4963}\ \text{EF68E}$$

$$+ \underset{(1.98)}{3.1244}\ \text{QFLEX}$$

see = 3.89 RB2 = .330 dw = 2.03

19.9 FIPVB12 Purchases of Canadian corporate shares on a portfolio basis by U.S. residents. Gross new issues, less retirements, plus net trade in outstanding shares

1Q57-4Q68 OLS

$$\text{FIPVB12} = \underset{(1.19)}{16.956}\ \text{QMIDEAST} - \underset{(6.73)}{45.965}\ \text{QUSTAX} - \underset{(7.20)}{72.855}\ \text{QBROKE}$$

$$+ \text{JW[J1D(RHOR-RHOR2)]} + \text{JW[J1D(VCN\$2)]}$$

t	JW[J1D(RHOR-RHOR2)]		JW[J1D(VCN$2)]	
0	2.7467	(.25)	223.4749	(5.47)
-1	7.8402	(1.08)	155.1909	(5.47)
-2	9.0803	(1.07)	99.3222	(5.47)
-3	6.4669	(.97)	55.8687	(5.47)
-4			24.8305	(5.47)
-5			6.2076	(5.47)
Sum W =	26.1341	Z1Z2	564.8948	Z2

see = 17.85 RB2 = .675 dw = 1.41

19.10 FIGB13 Sales of Government of Canada, provincial and municipal bonds in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds

1Q54-4Q68 OLS

$$\underset{}{FIGB13} = \underset{(3.13)}{18.795} - \underset{(1.07)}{.01625}\ J1L(LGB13) + \underset{(3.60)}{11.684}\ (RL-RLUK)$$

$$+ \underset{(14.74)}{1.0051}\ ZEUROF + \underset{(11.45)}{142.32}\ QEUROPM$$

see = 11.26 RB2 = .900 dw = 2.11

19.11 FIBL13 Sales of Canadian corporate bonds and shares in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds and shares

1Q55-4Q68 OLS

$$FIBL13 = - \underset{(.59)}{12.950} - \underset{(9.57)}{.02420}\ J1L(LDIPRV13) + \underset{(5.20)}{18.519}\ RHO$$

$$+ \underset{(3.38)}{.04724}\ J4A[(IME)(PIME)+(INRC)(PINRC)-YCR-CCAC\$]$$

see = 18.28 RB2 = .626 dw = .94

19.12 FOPL12 Purchases of U.S. bonds and shares by Canadians. Gross new issues, less retirements, plus net trade in outstanding bonds and shares

2Q57-4Q68 OLS

$$\frac{FOPL12}{PFX} = -\underset{(4.35)}{6303.6}\ J1L(A12/V) - \underset{(1.51)}{8.1488}\ (RHO-RHO2)$$

$$+\ JW(ODG2)$$

t	JW(ODG2)	
0	.70846	(8.60)
-1	.65786	(8.60)
-2	.60725	(8.60)
-3	.55665	(8.60)
-4	.50604	(8.60)
-5	.45544	(8.60)
-6	.40483	(8.60)
-7	.35423	(8.60)
-8	.30363	(8.60)
-9	.25302	(8.60)
-10	.20242	(8.60)
-11	.15181	(8.60)
-12	.10121	(8.60)
-13	.05060	(8.60)
Sum W =	5.31345	Z1

see = 23.76 RB2 = .682 cov = 88.98% dw = .81

19.13 FIYCRE12 Canadian corporate retained earnings accruing to U.S. shareholders

1Q55-4Q68 OLS

$$FIYCRE12 = \underset{(3.43)}{30.399} - \underset{(1.80)}{7.7577}\ QC1 - \underset{(2.83)}{11.520}\ QC2 - \underset{(1.76)}{7.1180}\ QC3$$

$$+\ \underset{(15.11)}{.49138}\ (LDIRV12/KB\$)(YC-TCA)$$

$$-\ (MDIV\$12)(LDIRV12/[LDIRV12+LPCV12])$$

see = 17.38 RB2 = .858 cov = 10.89% dw = 1.31

Sector 20. International Portfolio Positions

Technical Relationships

20.1 LGB12 Government of Canada, provincial and municipal bonds, direct and guaranteed, held by U.S. residents

LGB12 = J1L(LGB12) + FINIPM12 + FINIGF12 + FITOGB12 + FIRETG12

20.2 LCB12 Canadian corporate bonds and debentures held by U.S. residents

LCB12 = J1L(LCB12) + FINIB12 + FITOBB12 + FIRETB12

20.3 LPCV12 Value of common and preferred Canadian corporate shares held by U.S. residents

LPCV12 = (PKB/J1L(PKB)+YCR/VKB)(J1L(LPCV12)) + FIPVB12

where:

PKB = KB$/(KIB+KME+KNRC)

20.4 LDIRV12 Replacement value of the stock of U.S. direct investment in Canada, including Canadian corporate retained earnings accruing to U.S. direct investors

LDIRV12 = (PKB/J1L(PKB))(J1L(LDIRV12)) + FIDI12 + FIYCRE12

where:

PKB = KB$/(KIB+KME+KNRC)

20.5 LDIPRV13 Replacement value of the stock of direct and portfolio investment in Canada by other countries, including Canadian corporate retained earnings accruing to shareholders of other countries

LDIPRV13 = (PKB/J1L(PKB))(J1L(LDIPRV13)) + FIDI13

+ FIBL13 + FIYCRE13

20.6 LGB13 Government of Canada, provincial and municipal bonds, direct and guaranteed, held by residents of other countries

LGB13 = J1L(LGB13) + FIGB13

20.7 A12 Book value of U.S. indebtedness to Canada, including retained earnings accruing to Canadian shareholders

A12 = J1L(A12) + FODI12 + FOPL12 + J1D(AYCRE12)

20.8 A13 Book value of the indebtedness of other countries to Canada, including retained earnings accruing to Canadian shareholders

A13 = J1L(A13) + FOL13 + J1D(AYCRE13)

20.9 RVB12 Return to U.S. residents from Canadian business assets (percentage of total return)

RVB12 = 100(LDIRV12+LPCV12+LCB12)/KB$

20.10 RVB13 Return to residents of other countries from Canadian business assets (percentage of total return)

RVB13 = 100(LDIPRV13/KB$)

Sector 21. The Foreign Exchange Market and Short-Term Capital Flows

21.1 FXO Official excess demand for spot exchange

1Q63-4Q68 OLS

$$
\begin{aligned}
FXO = {} & \underset{(6.19)}{.84817}\ [ZRESD-J1L(URES)] \\
& - \underset{(4.28)}{.49354}\ [(PFX-1.081)/(.000081-[PFX-1.081]**2)] \\
& + \underset{(5.51)}{41110.9}\ [(1.08-PFX)-([(1.08-PFX)**2]**.5)] \\
& + \underset{(2.44)}{79.144}\ ZTR
\end{aligned}
$$

see = 84.93 RB2 = .849 dw = 1.61

21.2 FXP Private excess demand for spot exchange

1Q63-4Q68 OLS

$$
\begin{aligned}
FXP = {} & - \underset{(1.70)}{138.49} - \underset{(1.81)}{.21913}\ J2A(UBAL/PFX) + \underset{(2.37)}{.13145}\ J2A[J1L(ULS)] \\
& - \underset{(3.56)}{235.06}\ [RS-\left(\frac{LEURO}{MTM\$2+LEURO}\right)REUR \\
& \qquad -\left(\frac{MTM\$2}{MTM\$2+LEURO}\right)RTB2-\left(\frac{REUR}{RCD2}-1\right)(REUR-RTB2) \\
& \qquad -405.5\ (PFXF-PFX)/PFX] \\
& + \underset{(1.51)}{102.65}\ J1D[RS-\left(\frac{LEURO}{MTM\$2+LEURO}\right)REUR \\
& \qquad -\left(\frac{MTM\$2}{MTM\$2+LEURO}\right)RTB2-\left(\frac{REUR}{RCD2}-1\right)(REUR-RTB2) \\
& \qquad -405.5\ (PFXF-PFX)/PFX] \\
& + \underset{(2.01)}{186.26}\ EIET + \underset{(10.42)}{621.68}\ EF68E
\end{aligned}
$$

see = 82.81 RB2 = .856 dw = 1.54

21.3 PFXF 90-day forward exchange rate (Canadian dollars per U.S. dollar)

1Q63-4Q68 OLS

$$PFXF = \underset{(1301.4)}{1.07828} - \underset{(3.06)}{.000011}\ J4A(UBAL/PFX)$$

$$+ \underset{(1.17)}{.001421}\ [RS-(\frac{LEURO}{MTM\$2+LEURO})REUR$$

$$-(\frac{MTM\$2}{MTM\$2+LEURO})RTB2-(\frac{REUR}{RCD2}-1)(REUR-RTB2)]$$

$$+ \underset{(2.88)}{.0000166}\ ZFXOF + \underset{(5.04)}{.01923}\ EP68E$$

see = .0019 RB2 = .645 cov = .17% dw = 1.57

Technical Relationships

21.4 PFX Equilibrium condition in the foreign exchange market, used to determine the spot exchange rate, PFX (Canadian dollars per U.S. dollar)

FXO + FXP = 0

21.5 FIS Balance of payments identity used to determine short-term capital flows as a residual

FIS = (FXO)(PFX) + ERES2ADJ - UBAL

21.6 UBAL12 Net balance of payments with the United States on current and long-term capital account (million Canadian dollars)

UBAL12 = X\$12 - M\$12 + FIDI12 + FINIPM12 + FINIB12

+ FINIGF12 + FIRETG12 + FIRETB12 + FILO12 - FODI12

+ FITOGB12 - FOPL12 + FIPVB12 + FITOBB12

21.7 UBAL Net balance of payments with all countries on current and long-term capital account (million Canadian dollars)

UBAL = UBAL12 + X$13 - M$13 + FIDI13 + FIGB13 + FIBL13 + FILO13 - FOL13

21.8 URES Canadian foreign exchange reserves, including gold, U.S. dollars, other convertible currencies and reserve position in the IMF (million U.S. dollars)

URES = J1L(URES) + FXO + ERES1ADJ + ERES2ADJ

21.9 ULS Net international short-term liabilities outstanding between Canada and the rest of the world (+ if net liability is of Canada to rest of the world) (million U.S. dollars)

ULS = J1L(ULS) + FIS/PFX